SONOMA COUNTY WATER AGENCY'S MIRABEL RUBBER DAM/WOHLER POOL FISH SAMPLING PROGRAM: YEAR 3 RESULTS 2002

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This study is the result of the efforts from several individuals. David Manning and David Cook (SCWA) contributed significantly to the development and implementation of the study plan, as well as in data collection. Erica Phelps (SCWA), Bill Cox (Dept. of Fish and Game), and Jeff Church (State Water Resources Control Board), greatly improved the writing and data presentation in this report through their diligent reviews of earlier drafts. Collecting the data presented in this report took an enormous effort from several individuals over the past four years, and without their contributions, this report would be much lighter on data. Bill Cox also participated in data collection. Although mentioned last, our foremost thanks and gratitude goes to the dedicated Natural Resources Program Assistances who spent countless hours in the field, often in unfavorable conditions, to insure that the study was completed in a timely and professional manner. Special thanks goes to Henning Fett, Heidi Fantacone, Ben White, Jeanine Phillips, Scott Cooper, Steve Brady, and Joe Pecharich for their hard work.

EXECUTIVE SUMMARY

The Sonoma County Water Agency (Agency) diverts water from the Russian River to meet residential and municipal demands. Water diverted is a combination of releases from upstream storage reservoirs and instream flow. The Agency's water diversion facilities are located near Mirabel and Wohler Road. The Agency operates five Ranney collector wells (large groundwater pumps) adjacent to the Russian River near Wohler Road and Mirabel that extract water from the aquifer beneath the streambed. The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed. To augment this rate of recharge, the Agency has constructed several infiltration ponds. The Mirabel Inflatable Dam (Inflatable Dam) raises the water level and submerges the intakes to a series of canals that feed infiltration ponds located at the Mirabel and Wohler facilities. The backwater created by the Inflatable Dam also raises the upstream water level and submerges a larger streambed area along the river. This increased depth and enlargement of the submerged area significantly increases infiltration to the aquifer.

Three species of fish (Chinook salmon, coho salmon, and steelhead) listed as threatened under the federal Endangered Species Act (ESA) inhabit the Russian River drainage. In December 1997, the U.S. Army Corps of Engineers, NMFS, and the Agency entered into a Memorandum of Understanding (MOU) for consultation under Section 7 of the ESA to evaluate the effect of certain Russian River activities, including the Agency's water supply facilities and operations, on the three listed fish species. Section 7 of the ESA requires preparation of a Biological Assessment to evaluate these potential effects, and pursuant to the MOU the Agency is designated as the non-federal representative to prepare the Biological Assessment. The scope of this study is limited to assessing the potential for the Agency's Inflatable Dam to adversely affect Chinook and coho salmon and steelhead. Results from this study will be incorporated into the Biological Assessment.

The three listed species are anadromous, meaning they spawn and rear in freshwater, then migrate to the ocean where they grow and mature. They then migrate back to their natal freshwater habitat where they spawn and complete their life cycle. Chinook salmon, coho salmon, and steelhead use the lower mainstem Russian River (including the study area) primarily as a migration corridor. Adults pass through the Mirabel Reach during their migration to upstream spawning and rearing habitat. Juveniles (smolts) migrate through the area during their downstream journey to the ocean. Steelhead have been observed/captured in the study area throughout the summer period, indicating that either they migrate at low levels throughout the year, or that rearing occurs in the area, albeit at very low levels. Under current conditions, summer water temperatures limit salmonid rearing in the mainstem Russian River.

The Inflatable Dam has the potential to impact salmon and steelhead through; 1) altering habitat composition, 2) altering water temperature and water quality in the lower river, 3) impeding downstream migration of juveniles, 4) impeding upstream migration of adults, and 5) altering habitat to favor predatory fish. This study was developed in cooperation with the National Marine Fisheries Service and the California Department of Fish and Game to assess the potential for the dam to adversely impact listed species.

Although the operation of the Inflatable Dam has the potential to negatively impact adult and juvenile salmonids, no studies have been conducted to assess the actual effects of the dam's operations on salmonid populations. In light of these uncertainties, the Agency is conducting a five-year study to assess the potential impacts associated with the facilities, and to develop mitigation measures as appropriate. This report documents the results of the third year of study.

WATER TEMPERATURE

The main objective for this study could not be assessed in 2002 because of the loss of the data logger from Station #1. However, based on data collected in 2001, the Wohler Pool and the resulting impoundment appear to have a small influence on the rate at which water warms. Water flowing through the Wohler Pool was estimated to increase (in magnitude) from 0.1 (September) to 0.6ºC (June) above what would have been expected without the dam in place in 2001. The increase in the rate at which water warms within the Wohler Pool due to the presence of the impoundment had the effect of raising the average monthly surface water temperature from 20.6 to 21.2 in June, from 20.5 to 21.0 in July, from 20.3 to 20.6 in August, and from 18.6 to 18.7 in September of 2001.

Compared to proposed water temperatures standards for the Russian River, water temperatures in the study area were sub optimal for at least the last month of the smolt emigration period, the entire juvenile steelhead-rearing period, and the beginning of the adult upstream migration period. The sub optimal conditions were similarly found above the influence of the impoundment, within the impoundment, and below the impoundment. Although the temperatures were often well above established temperature criteria, healthy appearing Chinook salmon and steelhead smolts were captured during periods when maximum daily surface temperatures ranged to 23.2ºC (see Section 3.0 for a detailed discussion of smolt emigration through the study area, including a comparison of water temperatures and smolts captured in the rotary screw traps). In addition, juvenile steelhead were captured and observed in the Wohler Pool throughout the summer months. Water temperatures were sub optimal during the first few weeks of the adult migration period, but steadily improved as the migration season progressed.

The shallow (approximately two to three meters) nature of Wohler Pool is not conducive to thermal stratification.

SMOLT EMIGRATION

In 2002, the traps were operated throughout the majority of the emigration period for the first time (March 1 though June 27). Since several operational factors vary between years (time of year that the traps are operated, size and number of traps deployed, and the efficiency of the traps), it is not possible to make direct comparisons between sampling seasons. Still, a few preliminary conclusions can be drawn from the data collected to date.

The beginning of the Chinook salmon downstream migration period was documented for the first time in 2002. Chinook salmon were captured in low numbers in the traps on March 1 (indicating that Chinook first start to emerge from the gravel in late February). The catch of Chinook smolts slowly increased during March and early April, peaked during the last two week in April and first two week in May, then slowly declined through the end of June.

The size of the Chinook smolt run was estimated over an 11-week period in 2002. Between March 26 and June 4, 2002, an estimated 215,875 Chinook smolts were estimated to have emigrated past the traps.

Wild steelhead smolts are less likely to be captured in the rotary screw traps compared to Chinook smolts. Steelhead emigrate at a much larger size, and are stronger swimmers (based on size) and may be less likely to be captured, particularly by the 5-foot traps. For the season, 249 wild steelhead smolts were captured in the rotary screw trap (Table 3-1). Steelhead smolts were captured primarily in mid March through April, with the run extending through May. Wild steelhead smolts in the Russian River emigrate primarily as 2-year-old fish.

The capture of Chinook and wild and hatchery steelhead smolts after inflation indicates that the dam is not a complete barrier to migration. Previous studies suggest that the dam may delay passage around the dam of at least some hatchery steelhead smolts. A companion study, (Manning *et al.* 2000 and 2003), was instituted to define the potential impacts of the dam on steelhead smolts. Chinook smolt emigration through the study area did not appear to be delayed by the dam. As part of the mark-recaptured study instituted to estimate Chinook smolts abundance, Chinook smolts were marked with an alternating upper and lower caudal (tail) clip on a weekly basis, then transported approximately 0.8 km upstream of the dam. On the day following a change in the clip used, Chinook smolts captured in the screw traps almost invariably possessed the new clip. Few Chinook smolts were recaptured bearing the previous weeks clip, which would indicate that they had required more than 48 hours to pass the dam. Chinook smolts are two to four months old at the time of emigration, and are much smaller than steelhead smolts that emigrate as two-year-olds. The smaller sized Chinook smolts maybe better at passing over the dam compared to the larger steelhead smolts.

WOHLER POOL FISH COMMUNITY

During four years of sampling, four species of fish, smallmouth bass, Sacramento sucker, hardhead, and tule perch have dominated the fish community above the Inflatable Dam (Reaches 2, 3, and 4). The fish community in Reach 1 differed from the above dam Reaches by having a greater abundance of sunfish and tule perch, and a reduction in the abundance of smallmouth bass and hardhead. Wild and hatchery salmonids have been collected in relatively low numbers, primarily in Reaches 2 and 3 (“Wohler Pool”).

Three potential salmonid predators inhabit the study area, Sacramento pikeminnow, smallmouth bass, and largemouth bass (although two striped bass have also been captured in the Wohler pool). Pikeminnow were found in relatively low numbers. Although few adult pikeminnow were captured, they are capable of attaining a size large enough to feed on both Chinook salmon and steelhead smolts, and are a longed lived species (possibly up to 16 years (Moyle 2002). Smallmouth bass are the most abundant species inhabiting the study area. The majority of smallmouth bass captured were young-of-the-year, however. No smallmouth bass large enough to prey on steelhead smolts greater than 140 mm in length, and few smallmouth bass large enough to feed on an 80 mm FL Chinook smolts were captured. It is not known if the low number of older smallmouth bass is due a high rate of mortality among YOY bass, or a high rate of dispersal by YOY bass to areas outside of the study area. Winter habitat conditions (i.e., when the dam is deflated) may a least partially explain the poor recruitment of smallmouth bass to older age classes (see below). Very few largemouth bass were captured. Abundance of largemouth bass was highest in Reach #1 in all years sampled. All three predator species attain a size sufficient to prey on Chinook salmonids by the start of their third year of life (age 2+).

VIDEO MONITORING

Based on the results of video monitoring from 1999 through 2002, Chinook salmon and steelhead appear to be highly successful in finding and ascending the fish ladders around the Inflatable Dam. In 2002, approximately 5,500 adult Chinook salmon were counted ascending the fish ladders at the Mirabel Dam. The 2002 run represents an approximate 3.5 times increase over the number of Chinook salmon counted passing the dam in 2000, when virtually the entire run was surveyed. This is in contrast to historical literature that suggests that Chinook salmon were never abundant in the Russian. In 2001, approximately 1,380 adult Chinook salmon were observed migrating upstream through the fish ladders. The Chinook run essentially began in early September during the four years sampled (1999-2002). The entire spawning run has been surveyed in its entirety in 2000, only (Chase *et al*. 2001). The run peaks in October and November and ends in late December. During August of each of the first three years sampled, one Chinook salmon has been observed in the fish ladders, and nine were counted in 2002. Relatively large numbers of salmon have not been observed prior to October in any year.

In 2002, 76.5 percent of the fish were counted over six days: October 1 and 2, (21.1 percent, primarily on the 2nd), October 15 and 16 (9.9 percent), and November 16 and 17 (45.6 percent). The 2,213 Chinook salmon counted on November 17 was greater than any annual total count from the previous three years sampling.

Based on the paucity of historical records of Chinook salmon inhabiting the Russian River, the genetic origin of the Chinook salmon in the Russian River has been debated. There are at least three hypotheses to explain the presence of Chinook in the basin. First, they are remnants of a native run that was largely unnoticed during the past 100 years (possibly existing at very low population levels). Secondly, they may have resulted from the extensive stocking programs carried out over the last 100+ years. Finally, they may be strays from the Eel and/or the Sacramento rivers. Preliminary data from a genetics study conducted by the Bodega Marine Lab (BML 2002) concluded that the Russian River Chinook population is not closely related to Eel River or Central Valley (Sacramento-San Joaquin rivers) populations. Further, BML (2002) states that “Chinook in the Russian River do appear to belong to a diverse set of coastal Chinook populations.” Based on the results of the BBML, the leading hypothesis for the origin of the Russian River Chinook salmon is that they are a native run that has been largely unnoticed. The reason why these fish showed up in relatively large numbers in 2002 is unknown.

Adult steelhead began their upstream migration in late October, however, the majority of their run occurs after the dam is deflated. Thus, little run information is available for this species.

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1.0 INTRODUCTION

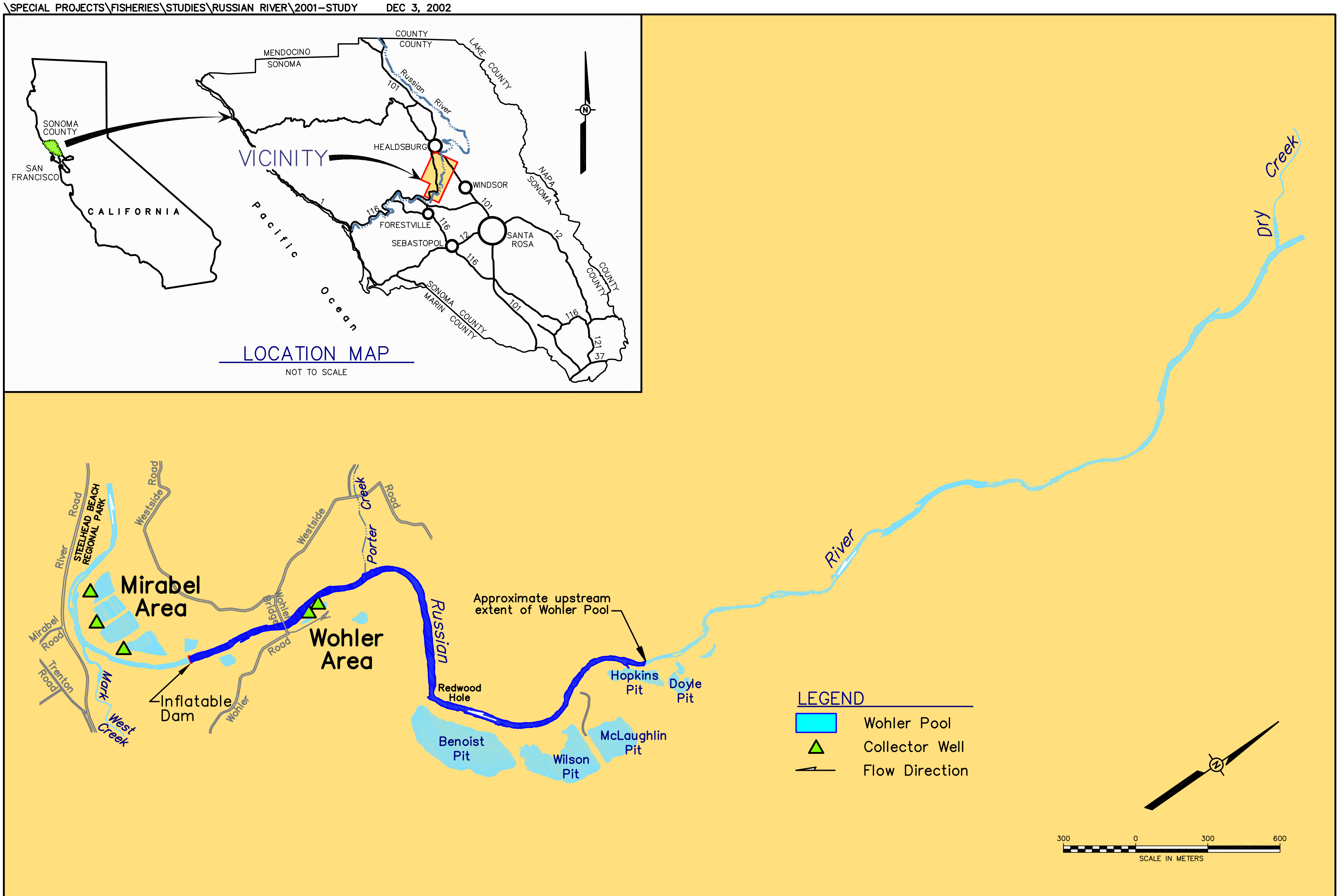
The Sonoma County Water Agency (Agency) diverts water from the Russian River to meet residential, municipal, and agricultural demands. Water diverted is a combination of releases from upstream storage reservoirs and instream flow. The Agency's water diversion is located near Mirabel (Figure 1-1). The Agency operates five Ranney collector wells (large groundwater pumps) adjacent to the Russian River that extract water from the aquifer beneath the streambed. The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed. To augment this rate of recharge, the Agency has constructed several infiltration ponds. An inflatable dam (Inflatable Dam) raises the water level and submerges the intakes to three diversion pumps (Figure 1-2). The water is pumped through a dike into a system of canals that supply water to five infiltration ponds. Water is also diverted through two screened control gates that feed two additional infiltration ponds at the Wohler facility. The backwater created by the Inflatable Dam also raises the upstream water level and submerges a larger streambed area along the river. This increased depth and enlargement of the submerged area significantly increases infiltration to the aquifer.

The dam is generally inflated between April and June and is deflated between late-September and mid-December of most years. However, the dam may be inflated during any month of the year, depending on conditions. The actual timing of dam inflation and deflation varies annually depending on a number of factors including, water demand, air temperature, precipitation, and river flow. The Inflatable Dam creates an impoundment that is approximately 5.1 kilometers in length (Wohler Pool). Within the impounded reach, water depth is increased and current velocity is decreased, compared to unimpounded conditions. These changes to the natural hydrology of the river have the potential to alter species composition, distribution, and abundance within the affected reach.

The Russian River provides habitat for several special status fish species, including three that are protected under the Endangered Species Act (ESA). On October 31, 1996, the National Marine Fisheries Service (NMFS 1996) listed coho salmon as threatened under the ESA within the Central California Coast Evolutionarily Significant Unit (ESU), which includes the Russian River. On August 10, 1997, NMFS listed steelhead as threatened under the ESA within the Central California Coast ESU (NMFS 1997), which includes the Russian River. On September 16, 1999, NMFS listed Chinook salmon as threatened under the ESA within the California coastal ESU (NMFS 1999), which also includes the Russian River. In addition, coho salmon inhabiting streams south of Punta Gorda (which includes the Russian River) have been listed by the Department of Fish and Game as endangered under the California endangered species act.

Chinook salmon, coho salmon, and steelhead use the lower mainstem Russian River (including the study area) primarily as a migration corridor. Adults pass through the Mirabel Reach of the river during their migration to upstream spawning and rearing habitat. Juveniles (smolts) migrate through the area during their downstream journey to the ocean. However, small numbers of steelhead have been observed/captured in the study area throughout the summer period, indicating that either they migrate at low levels throughout the year, or that rearing occurs in the area, albeit at low levels.

In accordance with Section 7(a)(2) of the ESA, federal agencies must consult with either the USFWS and/or the NMFS to "insure that any action authorized, funded, or carried out by such an agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat.…" In the present case, the endangered species are anadromous salmonids, which are managed by the NMFS. The U.S. Army Corps of Engineers, as the federal sponsor, and the Agency, as the local sponsor, entered into a Memorandum of Understanding (MOU) with the NMFS to begin the consultation process in December 1997. The MOU covers the Agency's flood control and water supply projects throughout the Russian River Basin. The Agency is preparing a Biological Assessment of its operations and facilities to assess potential impacts to ESA protected species. The scope of this study is limited to assessing the potential for the Agency's Inflatable Dam to adversely affect Chinook and coho salmon and steelhead. Results from this study will be incorporated into the Agency's Biological Assessment.



SONOMA COUNTY WATER AGENCY

Figure 1-1 Map of Study Area

Figure 1-2. The Mirabel Inflatable Dam (lower picture) and a portion of Wohler Pool (upper picture).

The Inflatable Dam has the potential to negatively impact several phases of the salmonid life history:

- The impoundment slows the flow of water through the basin, and may result in an increase in water temperatures downstream of the dam. An increase in temperature may degrade conditions if juvenile steelhead rear in the lower river.
- The impoundment created by the dam affects approximately 5.1 km of river, essentially creating a long pool. The impoundment decreases current velocities which smolts use during their downstream migration to the ocean. The loss of this tactile cue may result in smolts becoming disoriented while passing through the impoundment, and this may result in a delay in outmigration. Although there are three avenues for juvenile fish to pass by the dam (going over the dam and through the fish ladders and fish bypass facilities), fish that become disoriented may have difficulty finding these passage routes. This potential impact is only partially addressed in this study. A companion study (Manning *et al.* 2001, Manning *et al.* 2003) covers this topic in detail.
- The dam forms an 11-foot high barrier that effectively blocks upstream migrating adult salmonids. Although the dam is equipped with two denil type fish ladders; the effectiveness of the ladders has not been evaluated prior to this study.
- The combination of warmer, deeper, and lower velocity habitat may improve habitat conditions for predators such as Sacramento pikeminnow, smallmouth bass, and largemouth bass. Adults of these three species include small (smolt sized) fish in their diets. If the impoundment improves habitat conditions and leads to larger populations of the three predators, this could potentially increase mortality (through predation) on emigrating smolts.

Although the operation of the Inflatable Dam has the potential to negatively impact adult and juvenile salmonids, no studies have been conducted to assess the actual effects of the dam's operations on salmonid populations. In light of these uncertainties, the Agency is conducting a five-year study to assess the potential impacts associated with the facilities, and to develop mitigation measures as appropriate.

Prior to initiating this 5-year study, the Agency conducted a study entitled "Sonoma County Water Agency's Mirabel Inflatable Dam/Wohler Pool Reconnaissance Fish Sampling Program" (Chase *et al.* 1999). That program assessed the appropriateness of a variety of sampling methodologies to assess fish and aquatic habitat conditions in the Wohler Pool. The results of that study (Chase *et al.* 2000a) form the basis for the development of the study plan used for this project (Chase *et al* 2000b). This report documents the results of the third year of study.

1.1 STUDY AREA

The study area encompasses the Russian River from approximately 2.3 river kilometers (RK) downstream of the Inflatable Dam (Steelhead Beach Regional Park) to approximately 11.2 RK upstream of the dam (Figure 1-1). During the initial year of this 5-year study (2000), each sampling location was plotted on a base map using GPS coordinates.

Steelhead Beach Sampling location is a relatively large (approximate 620 meter long) natural pool located downstream of the dam. This is the only sampling habitat that is totally outside of the dam's influence. Wohler Pool is a 5.1 km long impoundment formed by the dam. The water surface elevation (depth) and current velocity in the lower 3.0 km of the impoundment is significantly influenced by the dam. The water surface elevation in the upper 2.1 km of the impoundment is only minimally influenced by the dam, ranging from approximately eight inches at the lower end of the reach to no influence at the upper end of the reach. Current velocity increases with distance upstream through the upper reach of the impoundment.

The following are landmarks and geographical names used throughout this study, and the types of sampling conducted at each location. River kilometer designations were taken from the aerial photographs taken for the County of Sonoma Aggregate Resources Hydrology Monitoring program.

1) Steelhead Beach Regional Park: Located at RK 34.8
- Boat electrofishing station
- Continuous water temperature monitoring station

2) Below Dam sampling station: Located at RK 36.3 (60 m downstream of the Inflatable Dam.
- Rotary Screw trap
- Continuous water temperature monitoring station

3) Mirabel Inflatable Dam: Located at RK 36.4
- Boat electrofishing station
- Upstream (video) monitoring station
- Continuous water temperature monitoring station
- Water quality profile monitoring station

4) Lower Wohler Pool: Impoundment formed behind Inflatable Dam: RK 36.4 to RK 39.4
- Boat electrofishing station
- Continuous water temperature monitoring station
- Water quality profile monitoring station

5) Upper Wohler Pool Reach: RK 39.4 to RK 41.5
- Boat electrofishing Station
- Continuous water temperature monitoring station
- Water quality profile monitoring station

6) Below Dry Creek Confluence: RK 47.9
- Continuous water temperature monitoring station

1.2 HISTORICAL LOWER RUSSIAN RIVER FISH SURVEYS

The lower Russian River fish community has been surveyed on several occasions between 1954 and the present (e.g., CDFG 1954, 1955, 1957, 1984, Hopkirk and Northen 1980, Nielsen and Light 1993). These surveys have generally been conducted during the summer (July through August) period. Sampling techniques were generally limited to beach seining.

To date, 29 species, including 14 native species, have been collected or observed during video monitoring in the lower Russian River during the 1999 through 2002 sampling seasons (Table 1-1). Five additional species of fish have also been reported in the Russian River. Coho salmon inhabit streams located primarily downstream from the Inflatable Dam, and at least historically, inhabited a small number of streams above the dam. Coho salmon have also been reported in the Dry Creek Basin in recent years, however, they have not been observed during this study. River lamprey are occasionally observed/captured in the river as well. White and green sturgeon (*Acipenser transmontanus and A. medirostris*), occasionally entered the Russian River, at least historically, although these species apparently did not spawn or rear their young in the river, and a third species, pink salmon (*O. gorbuscha*) is believed to be extirpated from the river. During historical surveys, native resident fish (Sacramento sucker and Sacramento pikeminnow), introduced sunfish (e.g., smallmouth bass and green sunfish), and juvenile American shad dominated the catch. Russian River tule perch were collected in low numbers during all surveys. It is important to note that beach seines are biased towards capturing smaller individuals, and are limited to sampling relatively shallow habitats that have smooth, unobstructed substrates, with moderately sloped contours. Beach seines are generally not effective at capturing species that are found in heavy cover (e.g., adult smallmouth bass), or fast swimming species (e.g. adult pikeminnow).

Table 1-1. Common and scientific names of species captured in the Russian River during 1999 through 2001 sampling efforts, including their status (native or introduced), life history strategy (anadromous or resident), and their regulatory status.

Common Name	Scientific Name	Status	Observed in current study	Regulatory status[1]
American shad	*Alosa sapidissima*	Introduced	Anadromous	--
Sacramento sucker	*Catostomus occidentalis*	Native	Resident	--
California roach	*Lavinia symmetricus*	Native	Resident	CSC[1]
Hardhead	*Mylopharodon conocephalus*	Native	Resident	CSC
California blackfish	*Orthodon microlepidotus*	Uncertain[3]	Resident	--
Hitch	*Lavinia exilicauda*	Native	Resident	--
Pikeminnow	*Ptychocheilus grandis*	Native	Resident	--
Fathead minnow	*Pimephales promelas*	Introduced	Resident	--
Golden shiner	*Notemigonus crysoleucas*	Introduced	Resident	--
Common carp	*Cyprinus carpio*	Introduced	Resident	--
Threespine stickleback	*Gasterosteus aculeatus*	Native	Resident	--
Bluegill	*Lepomis macrochirus*	Introduced	Resident	--
Green sunfish	*Lepomis cyanellus*	Introduced	Resident	--
Redear sunfish	*Lepomis microlophus*	Introduced	Resident	--
White crappie	*Pomoxis annularis*	Introduced	Resident	--
Smallmouth bass	*Micropterus dolomuieu*	Introduced	Resident	--
Largemouth bass	*Micropterus salmoides*	Introduced	Resident	--
Prickly sculpin	*Cottus asper*	Native	Resident	--
Riffle sculpin	*Cottus gulosus*	Native	Resident	--
Tule perch	*Hysterocarpus traski*	Native	Resident	CSC
Channel catfish	*Ictalurus punctatus*	Introduced	Resident	--
White catfish	*Ameiurus catus*	Introduced	Resident	--
Black bullhead	*Ameiurus melas*	Introduced	Resident	--
Mosquitofish	*Gambusia affinis*	Introduced	Resident	--
Pacific lamprey	*Lampetra tridentata*	Native	Anadromous	--
Western brook lamprey	*Lampetra richardsoni*	Native	Resident	--
Chinook salmon	*Oncorhynchus tshawytscha*	Native	Anadromous	FT
Chum salmon	*Oncorhynchus keta*	Native/Stray	Anadromous	--
Steelhead	*Oncorhynchus mykiss*	Native	Anadromous	FT
Striped bass	*Morone saxitalis*	Introduced	Anadromous	--

[1]California species of special concern
[2]Listed as Threatened under the Federal endangered Species Act
[3]Status of this species is uncertain. Although they are native to the Sacramento River, their status in the Russian River is not clear (Hopkirk 1973).

Young-of-the-year and age-1 or older steelhead were collected infrequently during the summer rearing period. Summertime water temperatures are believed to limit steelhead in the lower river. During a 1954 study, four juvenile steelhead were captured at one site (water temperature 24.4° C), ranging in length from 10.7 to 18.3 cm (CDFG 1954). All steelhead were infected with external parasites. No juvenile steelhead were observed or captured during a 1984 CDFG study (Cox 1984). However, in one study (CDFG 1955) 153 steelhead (mainly young-of-the-year) were captured in the lower Russian River at 30 sampling stations (generally one beach seine haul per site). Coho and Chinook salmon have not been collected in the lower Russian River during the summer rearing period (July through September), although emigrating Chinook salmon smolts have been collected during the spring and early summer in the river (this report) and in the estuary (MSC 1997).

Based on four years of electrofishing surveys conducted in the Mirabel/Wohler Reach of the Russian River, three potential piscivorous predators inhabit the study area; the native Sacramento pikeminnow and introduced smallmouth and largemouth bass. A fourth potential predator, striped bass, also inhabits portions of the lower Russian River. However, only two striped bass have been captured in the study area during this study.

1.3 TARGET SPECIES

Six fish species of concern inhabit the study area: the three federally protected salmonids (Chinook salmon, coho salmon, and steelhead), and three potential predators (the native Sacramento pikeminnow, and the introduced smallmouth and largemouth bass). Assessing the potential influences of the dam on these species requires an understanding of their life history requirements. The following section provides a brief discussion of the life histories of each of the six species of concern. The life history discussions are limited to the life stages of each species likely to be present in the study area during periods of the year when the dam is inflated.

The discussions are limited to the specific life history requirements likely to be affected by the inflation of the Inflatable Dam. Discussion of salmonids was limited to the water temperature requirements (effects of flow on emigration is covered in Manning *et al.* 2001). The impoundment has the potential to provide spawning and rearing habitat for potential predators, therefore, a more detailed discussion of life history requirements are presented for these species

1.4 LIFE HISTORY REQUIREMENTS FOR TARGET SPECIES

1.4.1 Chinook Salmon

Two life stages of Chinook salmon are potentially affected by the Inflatable Dam: adults returning from the ocean, and smolts migrating to the ocean. Adult Chinook salmon migrate upstream through the study area to their spawning habitat, located primarily in mainstem Russian River primarily upstream of the city of Healdsburg (Cook 2003), and in larger tributaries such as Dry Creek. Upstream migration occurs from the last week in August through December (primarily October and November). The primary concern for upstream migrating adults is passage around the Inflatable Dam and water temperature conditions in the river at the start of the upstream migration period. Juvenile Chinook salmon (Figure 1-3) in the Russian River emigrate as fingerlings from approximately late-February through June (one to four months of age). Chinook salmon in the Russian River emigrate through the Wohler Pool at about 90 millimeters (mm) fork length (FL) (range 32 to 140 mm). Factors that stimulate downstream migration are not well known (Healey 1991), however, streamflow likely plays a role. The primary concerns for Chinook smolts are water temperature, passage around the Inflatable Dam, and exposure to predation.

Figure 1-3. Russian River Chinook salmon smolt.

Water temperature and dissolved oxygen (DO) levels directly affect an organism's ability to survive, grow, and reproduce. Within a species-specific tolerance range, as water temperature increases, its growth rate and swimming performance will increase. Water temperatures above this range will result in an increased susceptibility to disease, a reduction in swimming performance, and a reduction in growth. Ultimately, excessively high temperatures can result in direct mortality. Factors such as DO levels and food availability affect temperature tolerance of salmonids. Optimal and lethal water temperature tolerances also vary by life stage (e.g., embryos are less tolerant of high temperatures than juveniles).

The upper lethal water temperature for Chinook salmon has been reported to be 25.0°C (Brett 1952 and Bell 1986), and 23.0°C (± 1.1°C) (Baker *et al.* 1995). The preferred temperature range for Chinook salmon has been reported to range from 12.0 to 14.0°C (Brett 1952) and 7.2 to 14.4°C (Bell 1986). Excellent growth rates for juvenile Chinook salmon have been reported to occur at temperatures ranging between 15.0 and 18.9°C (Brett *et al.* 1972, cited by Raleigh *et al.* 1986). Water temperatures above 21.1°C have been reported to stop downstream migration of Chinook salmon smolts (CDWR 1988 cited by RWQCB 2000).

Fall Chinook salmon reportedly migrate at temperatures ranging from 10.6 to 19.4°C, with an optimal temperature of 12.2°C (Bell 1991). Upstream migration by adult Chinook salmon in the San Joaquin River was halted when temperatures exceeded 21.1°C, but resumed when temperatures declined below 18.3°C (Hallock 1970, cited by ENTRIX (in DW Kelly and Associates and 1992)). The temperature of the water that the adults are exposed to prior to spawning can result in a reduction in survival of the subsequent embryos (Hinze 1959, cited by ENTRIX (in DW Kelly and Associates and 1992)). Eggs from salmon held for a prolonged time period at 15.6 to 16.7°C had a lower survival rate to hatching (70 percent) compared to eggs from salmon held at 12.8 to 15.0°C (80 percent survival).

1.4.2 Coho Salmon

Coho salmon have not been captured during the first three years of investigations. Coho salmon spawn primarily in tributaries located downstream of the study area. However, historically, coho salmon were known to inhabit a small number of tributaries upstream of the Mirabel/Wohler area. Coho migrate upstream during the fall (November and December), and juvenile emigration occurs during the spring (March through May). Coho salmon spawn and rear in tributaries, thus the only life stages potentially affected by the dam are emigrating smolts and upstream migrating adults. Coho salmon, if present, are likely to be affected in much the same way as Chinook salmon. Coho salmon emigration is affected by flow conditions, water temperature and day length (Shapovalov and Taft 1954).

The upper lethal temperature for coho fry has been reported to range from 22.9 to 25.0°C, depending on the temperature that the fish were acclimated to (5.0 to 23.0°C, respectively) (Brett 1952, DeHart cited by Konecki et al. 1995), 25.6°C (Bell 1986), and 28.2 to 29.2°C (Konecki et al. 1995, Becker and Genoway (1979) cited by Konecki et al. 1995). Juvenile coho salmon were observed in a stream with maximum daytime temperatures of 29.5°C (although the daily minimum temperature was 12.5°C during this time, and food resources were plentiful, which may have increased the thermal tolerance of these fish) (Bisson et al. 1988).

Juvenile coho salmon rear at temperatures between 3.3 and 20.6°C (Bell 1986), but reportedly prefer water temperatures between 10.0 and 15.0°C (Hassler 1987) and 11.7 to 14.4°C (Bell 1986). The Environmental Protection Agency (EPA 1977, cited by Klamt 2000) developed the concept of the “Maximum Weekly Average Temperature” (MWAT). A MWAT is the highest temperature that an organism can survive over the long term and maintain a healthy population (the MWAT is based on a 7-day moving average, and is the warmest seven consecutive days recorded annually). The EPA determined that the MWAT for coho salmon was 17.7°C. Welsh et al. (2001) compared the distribution of juvenile coho salmon in 21 tributaries in the Mattole River Basin with the maximum weekly maximum temperature (MWMT), defined as the highest average maximum temperature over a seven day period, and the MWAT. The warmest tributaries supporting coho salmon had a MWMT of 18.0°C, and a MWAT of 16.7°C. All tributaries that had a MWMT of less than 16.3°C and a MWAT of less than 14.5°C supported juvenile coho salmon.

The maximum sustained cruising (swimming) speed of under yearling coho salmon occurred at 20.0°C; above this temperature, swimming speed decreased significantly (Griffiths and Alderice (1972) and Brett et al. (1958), cited by Bell (1986)). Growth of coho salmon fry was reported as high between 8.9 and 12.8°C, but decreased (from 55 mg/day to 35 mg/ day) when temperature was increased to 18.1°C (Stein et al. 1972). Coho salmon growth apparently stops at temperatures above 20.3°C (Bell 1973, cited by McMahon 1983). However, in a field study conducted in Washington, no differences in coho salmon growth rates were found between streams where the daily maximum water temperature exceeded 20.0°C during July and August and other nearby streams of similar size (Bisson et al. 1988). Sullivan et al. (2000) concluded that setting an upper threshold for the 7-day maximum temperature at 16.5°C would minimize growth loss for coho salmon. Thomas et al. (1986) examined the effects of fluctuating temperature on mortality, stress and energy reserves of juvenile coho salmon. Coho salmon held in a fluctuating environment of 6.5 to 20.0°C had higher levels of plasma cortisol (which may indicate that the fish were under stress), however, the fish did not exhibit common signs of stress, such as flashing, gasping at the surface, or disorientation. Thomas et al. (1986) also reported that all test fish survived when daily temperature fluctuation ranged from 5.0 to 23.0°C. Moyle et al. (1989) concluded that maximum water temperatures should not exceed 21.9 to 25.0°C for an extended period.

Holt et al. (1975) found that the percentage of coho salmon and steelhead dying after exposure to a bacterial infection increased with temperature from no mortality at a temperature of 9.4°C to 100 percent mortality at a temperature of 20.6°C. All control fish survived the maximum temperatures tested (23.3°C).

1.4.3 Steelhead

Steelhead may be adversely affected by the Inflatable Dam during the upstream and downstream migrations similar to Chinook and coho salmon. Adult steelhead migrate through the study area during the winter (December through March), and the smolts emigrate during the Spring (March through early June) In addition, low numbers of steelhead may rear in the Study Area throughout the summer. Low numbers of juvenile wild and hatchery steelhead have been observed in the study area during all three years of sampling. Steelhead smolts emigrate through the Wohler Pool at an average size of approximately 175 mm FL (range 83 to 259 mm). Young-of-the-year steelhead have been captured below the dam, measuring between 29 mm and approximately 130 mm FL, depending on the time of year.

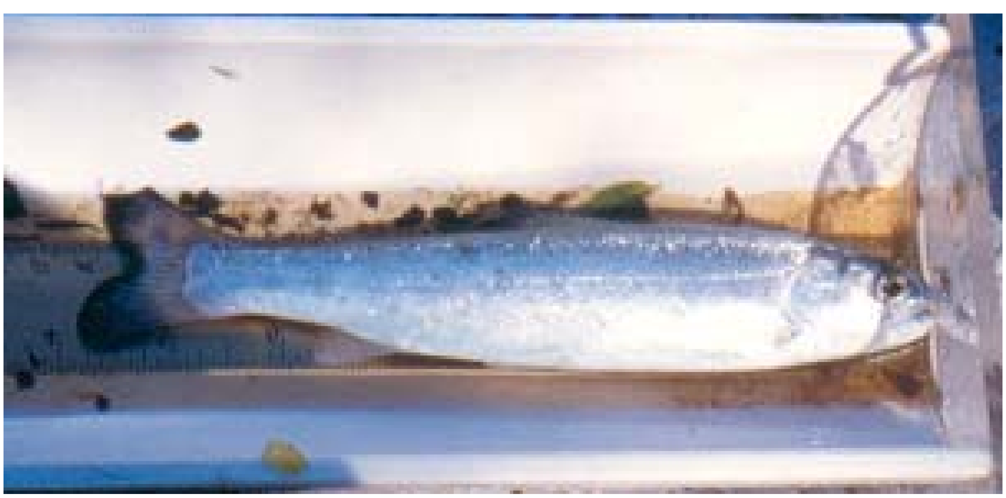


Figure 1-4 Russian River steelhead smolt

The upper lethal water temperature for steelhead has been reported to be 23.9°C (Bell 1986). However, in the Eel River, juvenile steelhead were observed feeding in surface waters with ambient temperatures up to 24.0°C (Nielsen *et al.* 1994). Optimal water temperatures for rearing steelhead have been reported to be 10.0 to 12.8°C (Bell 1984) and 14.2°C (Bovee 1978). Steelhead streams should have summer water temperatures between 10.0 and 15.0°C, with maximum water temperatures below 20.0°C (Barnhart 1986). Nielsen *et al*. (1994) reported an increase in agonistic behavior and a decrease in foraging as stream temperatures increased above 22°C. Steelhead were not observed to move into thermally stratified pools at temperatures below 22°C. Sullivan et al. (2000) concluded that setting an upper threshold for the 7-day maximum temperature at 20.5°C would minimize growth loss for steelhead. Roelofs *et al.* (1993) classified water temperatures in the Eel River as: extremely stressful for steelhead above 26.0°C, causing chronic physiological stress that jeopardizes survival at temperatures between 23.0 and 26.0°C, and as having chronic effects at temperatures between 20.0 and 23.0°C. A Maximum Weekly Average Temperature (MWAT) has not been calculated for steelhead.

1.4.4 Summary of Critical Water Temperature Levels

The above review of water temperature requirements for steelhead and coho salmon demonstrates the wide variation in thermal tolerances reported in the literature. These differences are likely a result of the local conditions that the test fish were adapted to. Site-specific temperature tolerance data are not available for salmonids in the Russian River Basin. A series of threshold temperatures were developed based on the available literature and recommendations of the NCRWQCB (Klamt 2000) (Table 1-2). The temperature regimes described do not necessarily represent absolute thresholds where impacts will occur to Chinook and coho salmon and steelhead inhabiting the Russian River. The thresholds do provide a framework to assess the overall suitability of the thermal regimes within the study area to support salmonids. Temperature thresholds used are divided into two classes; long term (chronic) affects, and short term (acute) affects. Salmonids can survive short-term exposure to relatively high temperatures without appreciable mortalities occurring. However, long-term exposure to moderately high temperatures can result in adverse affects (e.g., reduction in growth). At a sufficiently high temperature, mortality can occur over the short term. For example, Sullivan *et al.* (2000) estimated a 10 percent mortality rate for yearling rainbow trout exposed to a temperature of 26.5°C for six hours, and that the same rate of mortality would be expected to occur during a one-hour exposure to a temperature of 28.3°C. Water temperatures were evaluated primarily using a 7-day running average temperature and daily maximum temperatures.

The terms used to discuss the results of this study are similar, and can be confusing at first glance. Table 2-1 presents the terminology and their definitions used in this report.

Table 1-2. Terminology and definitions used to discuss the results of water temperature monitoring.

Terminology	Definition
Maximum Weekly Average Temperature (MWAT)	Highest average of mean daily temperatures over any consecutive 7-day period, recorded annually
Weekly average temperature	7-day moving average of the average daily temperature
Maximum Weekly Maximum Temperature (MWMT)	Highest average of maximum daily temperatures over any consecutive 7-day period, recorded annually
Weekly maximum temperature	7-day moving average of the daily maximum temperatures
Maximum daily average temperature	Highest average daily temperature recorded annually
Maximum annual temperature	Highest hourly temperature recorded annually

Table 1-3. Threshold temperature criteria and rational (with citations) used to assess thermal regimes in Mirabel reach of the Russian River.

Temp	Rational for 7-day running averages and MWAT thresholds	Source
14.5	Coho found in all Mattole River tributaries with MWATs below this threshold	Welsh *et al*. 2001
16.7	MWAT of Mattole River tributaries supporting coho salmon.	Welsh *et al*. 2001
17.8	Temperature regimes below this threshold should adequately protect salmonid rearing and outmigration life history phases.	NCRWQCB 2000
20.0	Temperatures above this threshold result in chronic effects to steelhead; upper range at which coho growth occurs	Roelofs *et al*. 1993; Bell 1973
21.1	Chinook smolt emigration and adult salmonid upstream migration inhibited	Hallock 1970 CDWR 1988
23.0	Chronic stress, survival jeopardized at temperatures above threshold for steelhead	Roelofs *et al*. 1993
Temp	**Rational for MWMT and maximum daily temperature thresholds**	**Source**
16.3	Coho found in all Mattole River tributaries with MWMT less than this threshold. Approximates the recommended MWMT (16.5°C) to protect coho growth.	Welsh *et al*. 2001 Sullivan *et al*. 2000
18.0	MWMT of Mattole River tributaries supporting coho.	Welsh et al. 2001
20.0	Maximum temperature for steelhead streams. Approximates the recommended MWMT (20.5°C) to protect steelhead growth.	Barnhart 1986 Sullivan *et al*. 2000
22.0	Salmonids utilization of cool water refuge begins to increase, feeding decreases	Nielsen *et al*. 1994 Sullivan *et al*. 2000
25.0	Lethal temperature range for Chinook salmon	Brett 1952
26.0	Approximate lethal temperature range for salmonids (time of exposure measured in hours). Extremely stressful for steelhead.	Sullivan *et al* 2000 Roelofs *et al*. 1993

1.4.5 Sacramento Pikeminnow

The Sacramento pikeminnow (Figure 1-5) is the largest member of the minnow family (Cyprinidae) inhabiting the Russian River. Pikeminnow are native to the Russian River, Sacramento-San Joaquin river systems, and the Pajaro and Salinas rivers (Moyle 2002). Prior to the introduction of other predators, pikeminnow were undoubtedly the top piscivore in the Russian River. Site-specific information on pikeminnow in the Russian River is limited, and most of what is known about their biology and life history comes from studies conducted in other river systems, primarily in the Sacramento and San Joaquin. In addition, a considerable amount of work has been conducted on the closely related northern pikeminnow (*P. oregonensis*) predation on salmonid smolts in the Columbia River Basin.

Historical observations of pikeminnow in the Russian River are generally limited to Taft and Murphy (1950), and a few CDFG reports, primarily during the late 1950s/early 1960s chemical treatment (rotenone) projects. Pikeminnow occupy pools throughout the Russian River and the lower reaches of the larger tributaries. Pikeminnow are native to the Russian River, and would be found in the area with or without the dam. Large pikeminnow are apparently widespread above the Wohler Pool, and were observed in most large pools sampled during a snorkel survey in 2002 (Cook 2003).

Pikeminnow prefer warm water streams with abundant pools (Taft and Murphy 1950, Moyle and Nichols 1973). Adult pikeminnow occupy deep pools with abundant cover, during the day they tend to be sedentary (Smith 1982**,** Brown 1990). Juveniles (70 to 120 mm SL) were found in riffles and runs (Smith 1982). Pikeminnow prefer relatively low velocity habitat (<15 cm/s), except when foraging or moving

Figure 1-5 Pikeminnow (with streamer tag) captured in the Wohler Pool, Russian River

from one pool to another, moderate depths (0.5 to 2.0 meters), and a substrate of gravel to boulder (Knight 1985).

Pikeminnow prefer warm water compared to salmonids. Pikeminnow are seldom abundant where water temperature does not exceed 15°C (Moyle 2002), and showed a preference for a water temperature of 26.0°C (Knight 1985). The critical thermal maxima temperatures were 28.3 °C for pikeminnow acclimated at 10°C and 37.2°C for pikeminnow acclimated to 25°C (Knight 1985). Pikeminnow survived temperatures of 30°C, but died when temperature was rapidly increased to 35°C (Cech *et al.* 1990). Pikeminnow are tolerant of low DO levels. Pikeminnow did not show a metabolic response to hypoxic conditions (DO levels at 25 percent of saturation for each temperature tested) at temperatures up to 25°C (Cech *et al.* 1990).

Adult pikeminnow feed primarily at dawn (Brown 1990), dusk and at night (Smith 1982, Brown 1990). Pikeminnow feed on aquatic insects as juveniles, switching to a diet primarily of fish as they grow (Moyle 2002). Taft and Murphy (1950) examined the stomach contents of 36 juvenile pikeminnow (ranging in length from 3.3 to 17.8 cm FL) captured in the Russian River near Cloverdale. The diet of these fish consisted entirely of aquatic insects. Merz and Vanicek (1996) compared the diets of juvenile pikeminnow and steelhead and Chinook salmon in the lower American River. They concluded that juvenile pikeminnow fed primarily on corixids (water boatmen) and chironomids (larval gnats), and that their diet did not overlap with either steelhead or Chinook salmon.

Adult Sacramento and northern pikeminnow are known to eat salmon and steelhead smolts (Moyle 2002, Vondracek and Moyle unpublished manuscript, Poe *et al.* 1991, Shively 1996, Vigg *et al.* 1991, Zimmerman 1999). Pikeminnow predation can be significant below large dams on the Columbia River where smolts can become disoriented or injured by passage past dams, and below hatcheries following large releases of smolts (Shively *et al.* 1996). However, salmonids seldom constitute a significant proportion of pikeminnow diet in free flowing sections of rivers (Buchanan *et al.* 1981).

Pikeminnow generally begin to include fish in their diet after reaching a length of 165 to 230 mm. Pikeminnow have been reported to begin preying on fish and crayfish at a size of 180 mm SL (Falter 1969, cited in Brown and Moyle 1981), 230-250 mm FL (Thompson 1959, cited in Brown and Moyle 1981), and greater than 165 mm FL (Buchanan et al 1981). Moyle *et al.* (1979) reported a transition in the diet from mainly insects to fish and crayfish at a length of approximately 200 mm SL (cited in Vondracek and Moyle, unpublished manuscript). In the Buchanan *et al.* (1981) study, 75 percent of the salmonids consumed were eaten by pikeminnow greater than 300 mm FL. Smaller fish fed on insects.

Buchanan *et al.* (1981) examined northern pikeminnow diets in free flowing sections of the Willamette River basin in Oregon. The study fish were collected during spring smolt emigration period. Pikeminnow fed primarily on insects, crayfish, and sculpin. Juvenile salmonids were found in 2 percent of the 1,127 pikeminnow stomachs examined.

Both Buchanan (1981) and Thompson (1959) (cited in Brown and Moyle 1981) found that pikeminnow were opportunistic, and fed on whatever prey source was most abundant. This may explain why they are such active predators of salmonids below dams and after hatchery releases. A similar response to hatchery releases and an increase in salmonids in the diet has been reported by Vondracek and Moyle (unpublished manuscript).

Zimmerman (1999) developed a linear regression for the size of salmonids that could be consumed by northern pikeminnow between 250 and 550 mm FL (the northern pikeminnow is closely related and similar in morphology to the Sacramento pikeminnow) (Table 1-4). Based on this regression, northern pikeminnow ranging in size from 250 and 550 mm FL can consume salmonids ranging in length from 116 to 227 mm FL. The largest pikeminnow captured in this study was 710 mm FL, thus it could consume larger prey items than those studied by Zimmerman.

Table 1-4. Theoretical size of salmonids that can be consumed by Pikeminnow between 250 and 550 mm FL (based on Zimmerman 1999).

Size of pikeminnow (FL)	Size of salmonid (FL)
250	116
275	125
300	135
325	144
350	153
375	162
400	172
425	181
450	190
475	199
500	209
525	218
550	227

From the above review of the literature, there appear to be three significant size classes of pikeminnow in terms of the potential to prey on salmonids. Pikeminnow that are less than 200 mm FL (fish are an insignificant part of their diet), those between 200 and 300 mm FL (fish comprise a small portion of the diet), and those greater than 300 mm FL (fish comprise a significant part of their diet).

Growth rate is an important factor to consider when assessing the potential for a predator to impact a prey species. Until the predator becomes large enough to feed on the prey species, they are not a threat. Lengths of pikeminnow captured in August (average between 1999 – 2002) in the Russian River are as follows (Table 1-5):

Table 1-5. Fork lengths of Sacramento pikeminnow captured in the Russian River in August (average over the 1999 – 2002 sampling seasons).

	Age 0+	Age 1+	Age 2+	Age 3+	Age 4+	Age 5+	Age 6 up
Number	161	75	15	11	6	8	10
Average	66	139	252	353	459	531	660
Range	35 - 95	110 - 175	195 - 300	320 - 385	410 - 455	515 - 555	590 - 710

In the Russian River, spawning takes place in April and May (Taft and Murphy 1950). Eggs are adhesive and are attached to rocks or gravel. Pikeminnow inhabiting large rivers and reservoirs migrate upstream into smaller tributary streams to spawn during high flows (Moyle 2002, Mulligan 1975). Pikeminnow inhabiting smaller streams migrate either upstream or downstream to spawn (Grant and Maslin 1999).

Pikeminnow eggs hatch in 4 to 7 days at 18°C, and the young fish begin to swim around in schools approximately one week later (Moyle 1976). In the Russian River, larval pikeminnow were first captured in screw traps in mid to late June in 2000 and 2002.

Adult pikeminnow make annual spawning migrations during the winter/spring (Harvey and Nakamoto 1999). Pikeminnow migrated anywhere from 2 to 92 km during spawning migration. Migration may be upstream or downstream. Pikeminnow tended to return to or near their home pool following the spawning migration. During the day, adult pikeminnow inhabit deep pools only. During the night, they may move into riffles or runs to feed. Pikeminnow make local upstream migrations in the spring and downstream migrations in the fall (Taft and Murphy 1950). Pikeminnow were observed during video surveillance of the fish ladders (see Section 5.0) migrating upstream into the Wohler Pool during the spring.

The presence of adult pikeminnow can result in a shift in habitat used by other (prey) species (Brown and Moyle 1991, Brown and Brasher 1995, Gard 1994). Juvenile rainbow trout and Sacramento suckers shifted to shallower, higher velocity (riffle) habitat, and threespine stickleback and juvenile California roach shifted to nearshore, shallow water habitat in the presence of pikeminnow.

Pikeminnow were seldom abundant where centrarchids were common (Moyle and Nichols 1973). Pikeminnow were found in areas with rainbow trout and California roach, but they were seldom abundant when found together. Pikeminnow abundance was limited by smallmouth bass predation in the South Fork Yuba River (Gard 1994).

1.4.6 Smallmouth Bass

Smallmouth (Figure 1-4) bass are native to the eastern half of the United States and southern Canada, originally inhabiting streams and rivers from southern Quebec to the Tennessee River in Alabama, and west to eastern Oklahoma (Carlander 1977). Highly esteemed as a game fish, they have been widely stocked outside of their native range. Smallmouth bass appear to be widespread throughout the mainstem Russian River, with peak abundances reportedly occurring in the Alexander Valley. Smallmouth bass are widespread and abundant in the Study Area.

Optimal water temperatures for growth range from 26 to 29°C, and preferred temperatures range from 21 to 27°C (data cited by Edwards *et al.* 1983, Carlander 1977). Growth reportedly does not occur at temperatures below 10 to 14°C. Smallmouth bass prefer DO levels in excess of 6.0 ppm. Edwards and Gebhart (1983) cite data showing that adult smallmouth bass seek cover when temperatures drop to 15 to 20°C, and become inactive at temperatures at a temperature of approximately 10°C.

Figure 1-6. Smallmouth bass captured in the Russian River.

Smallmouth bass will consume a wide variety of food items, including fish, crayfish, insects, and amphibians (Moyle 2002). Smallmouth bass have been documented to feed on salmonids, primarily under-yearling Chinook salmon smolts (same life stage found in the Russian River). Underyearling Chinook salmon comprised 59 percent of the diet of smallmouth bass in one Columbia River study (Tabor *et al.* 1993). However, in another study, also on the Columbia River, underyearling Chinook accounted for only 4 percent of smallmouth bass prey items (Poe *et al.* 1991). Zimmerman (1999) reported that subyearling Chinook salmon accounted for 12.4 to 25.8 percent of the diet of smallmouth bass collected in three sections of the Columbia River during a seven-year study (smallmouth bass were collected during the spring and summer smolt emigration period).

Zimmerman (1999) developed a linear regression for the size of salmonids that could be consumed by smallmouth bass between 200 and 400 mm FL (Table 1-6). Based on this regression, a 200 mm smallmouth bass can consume a 100 mm salmonid, and a 383 mm FL smallmouth bass (largest smallmouth bass captured in this study) can consume a 134 mm salmonid.

Smallmouth bass are spring spawners, and spawning is generally initiated after water temperature increases to 12.8 to 15.5°C (range 4.4 to 21.1°C) (Emig 1966). Preferred spawning substrate is gravel, but silt and sand can be utilized. Nests are generally built at depths between 0.3 to 0.9 m (Edwards *et al.* 1983). Spawning generally occurs in quiet backwater areas of streams.

Table 1-6. The theoretical maximum sized salmonid that can be consumed by smallmouth bass between 200 and 400 mm FL (based on Zimmerman 1999).

Size of smallmouth bass (FL)	Size of salmonid (FL)
200	100
225	104
250	109
275	114
300	119
325	123
350	128
375	133
400	138

1.4.7 Largemouth Bass

Largemouth (Figure 1-5) bass are native east of the Rocky Mountains from southern Quebec through the Mississippi River Basin to the Gulf of Mexico, east into the Carolinas and Florida (Carlander 1977). Largemouth bass have been introduced throughout the country because of their reputation as a game fish.

Little data are available on the abundance and distribution of largemouth bass in the Russian River. They are apparently confined to the lower sections of the river, but are not generally considered abundant. Largemouth bass were captured in low numbers in the present study.

In rivers, largemouth bass prefer low velocity habitats with aquatic vegetation (Stuber *et al*. 1982, Carlander 1977). Moyle and Nichols (1973) described habitat supporting largemouth bass in Sierra foothill streams as being warm, turbid pools with aquatic and floating vegetation. Substrate in these pools was typically sand or mud.

Stuber *et al.* (1982) reviewed the literature on largemouth bass, and concluded that optimal temperatures for growth of juvenile and adult largemouth bass range from 24 to 36°C. Little growth occurs below 15°C (Mohler 1966, cited by Stuber *et al.* 1982).

Figure 1-7 Largemouth bass captured in the Russian River

Largemouth bass feed primarily on fish and crayfish after reaching a size of 100 to 125 mm SL (approximately 125 to 150 mm FL). We are unfamiliar with any studies documenting largemouth bass predation on salmonids. This is likely because their habitats seldom overlap. Salmonids may become vulnerable to largemouth bass predation during the later half of the emigration period when stream flows decrease and water temperatures increase. Under these conditions, largemouth bass are more likely to become active. Largemouth bass have the well-earned reputation for being able to consume any animal that it can fit in its mouth, including small mammals, waterfowl, frogs, and fish.

Largemouth bass typically spawn in April and May after the water warms to approximately 13.9 to 16.1° C (Emig 1966). Largemouth bass reportedly spawn at depths ranging from 0.15 to 7.5 meters in depth (Stuber *et al*., 1982). However, the average depth which bass spawn is generally at the shallower end of this range. Largemouth bass nest were constructed at depths of 0.15 to 0.76 m, 1.2 to 1.8 m, and 0.15 to 2.0 m with an average of 0.6 m, in three studies cited by Carlander (1977), between 0.3 and 0.93 m (Stuber *et al*. 1982), and 1.0 to 2.0 m (Moyle 1976). Incubation (to hatching) of largemouth bass eggs is largely influenced by water temperature, and ranges from approximately 13 days at 10.0° C, to 1.5 days at 30.0° C (data cited by Carlander 1977).

2.0 WATER TEMPERATURE MONITORING

2.1 INTRODUCTION

During the typically warm summer period, water temperature tends to increase naturally as a river flows from its headwaters to the ocean. The rate of increase varies depending on climatic conditions, river morphology, and habitat quality. Impoundments such as Wohler Pool may degrade water quality, primarily by increasing the rate at which water temperature increases. Impoundments slow the flow of water through the basin. The longer the residence time, the greater the opportunity for water to be warmed through solar radiation. The primary objective of this study is to determine to what degree, if any, the impoundment increases the rate at which water warms compared to free flowing riverine conditions. The upstream most temperature data logger was not recovered at the end of the sampling season (the chain attaching the instrument to a tree on the shoreline was broken, and the unit was apparently removed from the site). Thus, this portion of the study could not be completed in 2002.

A secondary objective of this study is to provide a general description of the spring through fall thermal regime within the study area, and compare this to the temperature requirements of the target species (Chinook salmon, coho salmon, steelhead). Salmonid life stages potentially affected by an increase in water temperature associated with the Wohler Pool are: the spring emigration period, steelhead rearing (summer), and fall upstream migration period (there is essentially no salmonid spawning habitat within the footprint of the Wohler Pool).

The final objective of this study is to determine the potential for the Wohler Pool to become thermally stratified during the summer. The density of water decreases as the temperature increases (thus, warm water "floats" on top of cold water). When thermal stratification develops, a strong density gradient forms between the warmer surface water and the cooler water below. The density gradient prevents mixing between the two layers of water, and the bottom layer of water can remain several degrees cooler throughout the summer. The cooler layer of water, if present, could provide suitable temperatures for salmonids rearing in the mainstem river.

2.2 METHODS

Seven continuously recording water temperature-monitoring stations were selected within the study area (Figure 2-1). Water temperature data were collected using Hobo 8K data loggers (Onset Computers, Inc.). At stations 1 through 5 and 7, two data loggers were placed in the water column: one at approximately 0.5 meters deep, and the second approximately 2.0 to 4.0 meters deep, depending on the maximum depth at each station. At Station 6 (below the dam), one data logger was placed at the outlet of the west fish ladder. Data loggers were programmed to record temperature on an hourly basis, 24 hours a day. The temperature monitors were deployed on April 6, prior to dam inflation, at all stations except Stations 5 and 6, and on March 9 at Station 6 (Stations 5 and 6 are adjacent to each other, and differ in temperature only after the dam is inflated). Surface probes were deployed after the dam was inflated. Water temperatures were recorded at stations 2-5 and 7 though October 9, and through December 9 at Station 6. The probes at Station 1 were apparently tampered with sometime after June 27 (the last date that the logger was downloaded in the field), and all data after this point was lost.

Pre- and post-deployment, data loggers were calibrated to a National Institute of Standards and Technology (NIST) traceable thermometer. Data loggers were immersed in water at room temperature (approximately 20° C) and in an ice bath (approximately 0.2° C) for 20 minutes each. Data collected during calibration were compared to the NIST-traceable thermometer to determine accuracy. The standard set to determine the accuracy of each data loggers was set at ± 0.5°C.

Water quality profile (water temperature, dissolved oxygen, and conductivity) monitoring was conducted at four stations ranging from the Inflatable Dam (Station #5) upstream approximately 5.1 km (Station #2) (Figure 2-1). Water quality parameters were collected over the deepest section of each sampling station. Measurements were taken at 0.5 to 1.0 meter intervals. Water quality profiles were collected on a biweekly schedule. Water quality data was collected using a Yellow Springs, Inc., (YSI) 85 Portable Temperature/ DO/Conductivity meter. A table converting ºC to ºF is presented in Appendix A.

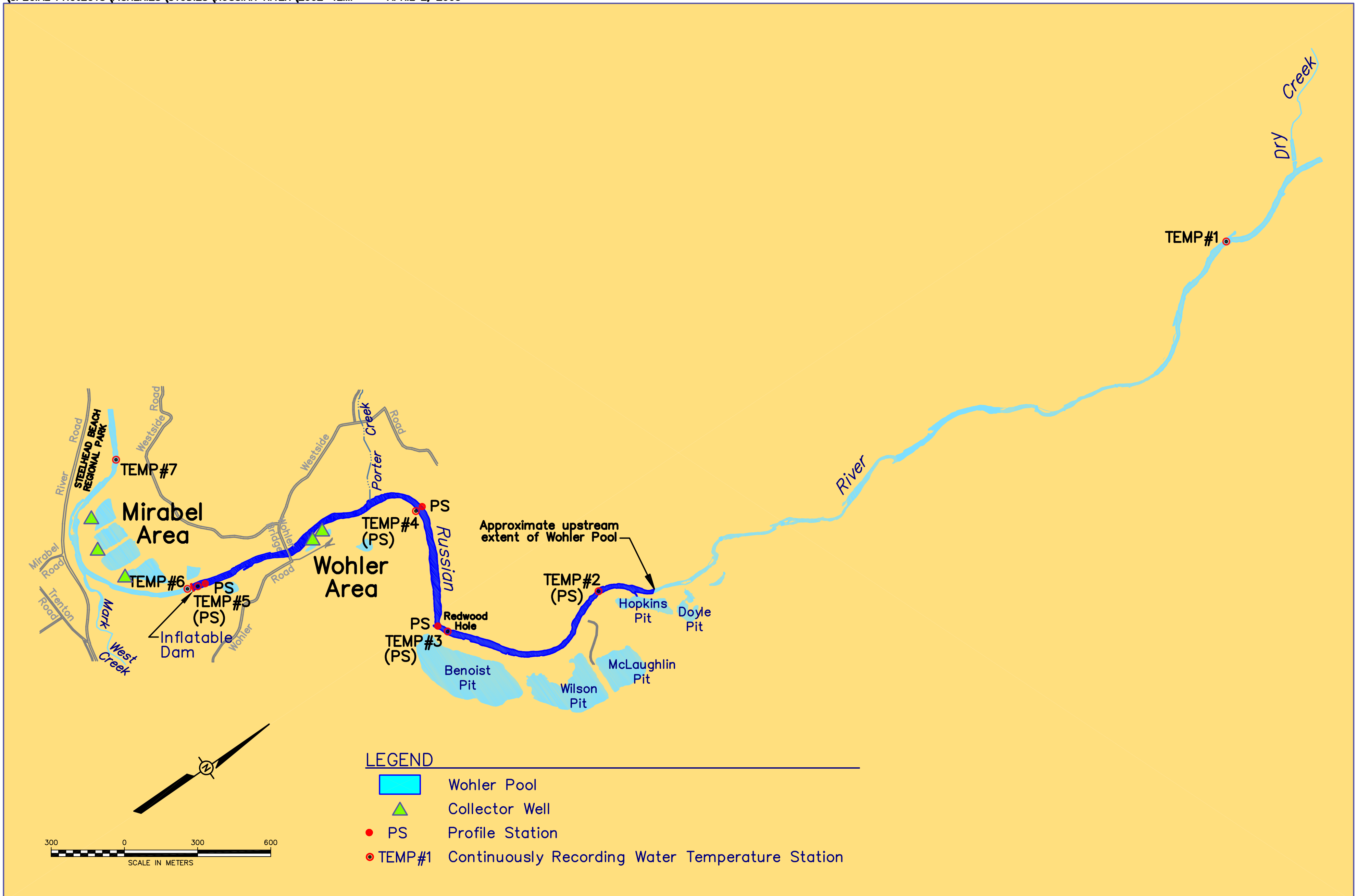


Figure 2–1 Continuous water temperature and water quality profile stations – 2002

2.3 RESULTS

Temperature criteria used for assessing the suitability of water temperatures in the project area are presented in Section 1.4.5. As discussed in that section, site-specific water temperature criteria are not available for fish inhabiting the Russian River. General temperature guidelines have been established based on data collected on the three species inhabiting rivers outside (and generally north) of the Russian River. However, the appropriateness for their use in the Russian River has not been verified in the field. These criteria provide a conservative framework for assessing the suitability of the thermal conditions in the Russian River to support the three listed salmonids.

2.3.1 Streamflow

Streamflow releases in the Russian River are controlled by the State Water Resources Control Board's Decision 1610 (SWRCB 1986), which stipulates that the annual minimum summer low flow in the Russian River downstream of Dry Creek as:

- 125 cfs during normal water supply conditions
- 85 cfs during dry water supply conditions, and
- 35 cfs during critical water supply conditions

Although streamflows above and below the Inflatable Dam are typically greater than the minimum allowable flow, the flow above and below the dam differs by the amount diverted by the Agency and other diverters. Low flow discharges measured above and below the Inflatable Dam have varied significantly during the first three years of this study. The 2002 water year qualified as a normal year under the conditions set by Decision 1610. Streamflows measured below the inflatable dam during June through August were intermediate to the flows released during the same time frame in 2000 and 2001.

In addition to flow, channel morphology is also different above and below the Inflatable Dam. Above the Wohler Pool is approximately 70 percent run, compared to habitat below the dam that is approximately 70 percent pool (Chase et al. 2000b). The difference in streamflow and channel morphology undoubtedly affects residence time of the water flowing through these reaches. The differences in streamflow and channel morphology affect the rate at which water temperature changes above and below the dam, thus, the above and below reaches are not directly comparable. The above reach was used to assess the effects of the dam on water temperature because the streamflow and channel morphology between the two reaches are similar.

Table 2-1. Average monthly flow (June through September) in 2000 (normal flow year), 2001 (dry year), and 2002 (dry spring).

Month	Average monthly flow (cfs) in 2000		Average monthly flow (cfs) in 2001		Average monthly flow (cfs) in 2002	
	Hacienda	Above Wohler	Hacienda	Above Wohler	Hacienda	Above Wohler
June	267	347	114	246	191	268
July	196	287	111	196	144	267
August	184	301	113	219	152	280
September	202	290	151	274	153	277

2.3.2 Continuous Temperature Recording

Water temperatures were recorded continuously at seven locations within the study area for varying lengths of time (Table 2-2) (see Appendices B and C for tables and graphs, respectively, of the daily maximum, average, and minimum temperatures recorded at each station). Water temperatures at Station #1 represent temperatures 6.5 RK above the influence of the impoundment. Station #2 is located at the upstream end of the impoundment and represents the temperature of the river as it first encounters the pool. The difference in the temperatures between Stations #1 and #2 represents the natural heating/cooling of the river just above the influence of the impoundment. Stations #3, #4 and #5 are located in approximately the upstream third, middle, and downstream end of the pool, respectively. Temperatures at these stations describe the thermal conditions within the impoundment. The differences in water temperatures between Stations #2 and #5 represent the cooling/heating of the river as it passes through the 5.1 km long Wohler Pool. Station #6 was located immediately below the dam, and is a mixture of surface and mid column water flowing both over the dam and through the fish ladders and fish bypass facilities. Station #7 is located approximately 2.3 RK downstream of the dam. The difference in temperature between Stations #6 and #7 represents the natural heating/cooling of the river just below the influence of the impoundment. However, water is diverted at Mirabel, and the streamflow between the dam and Station #7 is generally less than the streamflow at Stations #1 and #2. Therefore, the change in temperature between the dam and Station #7 are not directly comparable to the change in temperature above and within the impoundment.

Table 2-2. Dates of operation for data loggers at seven continuous temperature recording Stations, 2002.

Location	Dates of operation
Station 1 bottom	April 6 – June 7, data logger lost after this time
Station 1 surface	Not recovered
Station 2 bottom	April 6 – October 9
Station 2 surface	June 1 – October 9
Station 3 bottom	June 28 – August 8; August 23 – October 9
Station 3 surface	June 28 – August 7; August 24 – October 9
Station 4 bottom	April 6 – August 8; August 23 – October 9
Station 4 surface	June 6 – August 12; August 23 – October 9
Station 5 bottom	June 1 – October 9
Station 5 surface	June 1 – October 9
Station 6 bottom	March 9 – December 9
Station 7 bottom	April 6 – October 22
Station 7 surface	June 6 – September 3

2.3.3 Seasonal Water Temperatures within the Study Area.

The three listed salmonids migrate through the study area as juveniles and adults, and juvenile steelhead rear within the study area in low numbers. Thermal conditions providing adequate protection for juvenile and adult migrating steelhead and Chinook salmon should be suitable when the MWAT is below 17.8ºC and the MWMT is below 21.1ºC for migrating adults and 20.5ºC for Chinook and steelhead smolts. Rearing conditions for juvenile steelhead should be suitable when the MWAT is less than 17.8ºC and the MWMT should be below 20.5ºC to provide optimal growth conditions for juvenile steelhead (a reduction in the growth rate of greater than 10 percent has been reported for temperatures above 20.5ºC (Sullivan et al. 2002). Temperature above 26.0ºC can result in direct mortality in a matter of hours.

In general, water temperatures were sub optimal during at least a portion of the time for all life stages at all stations (Figures 2-3 – 2-9). The suitability of water temperatures during the spring juvenile emigration period generally declined as the season progressed. The sub optimal conditions were recorded at all stations, although the general trend was for the downstream stations (within and below the Inflatable Dam/Wohler Pool complex) to have less desirable conditions compared to the two upstream sites (Stations #1 and #2). Conditions were generally poor for rearing steelhead during July and August, before improving during the last two weeks in September. Conditions for upstream migrating adults (primarily Chinook salmon) were sub optimal during the first few weeks of the upstream migration period, but quickly improved during October when the majority of the fish began entering the river. Steelhead migration begins in late November/December, after temperatures have declined to acceptable levels.

2.3.3.1 Seasonal water temperatures during the smolt emigration period.

Overall, water temperature conditions were adequate for smolt emigration throughout the majority of the spring emigration period. Weekly average (≤ 17.8ºC) and weekly maximum (≤ 20.5ºC) temperatures were suitable for Chinook salmon and steelhead smolts until May 7 and May 28, respectively (Table 2-6). 94.6 percent of the Chinook smolts and 97.6 percent of the steelhead smolts were captured prior to the maximum weekly temperature exceeding 20.5ºC. The weekly average temperature exceeded 21.1ºC (the point that emigration has been halted in other river systems) on June 14, although, the emigration period is essentially over by this date. Chinook smolts were captured in the downstream migrant trap in low numbers through June 25. Spring water temperatures near the Inflatable Dam were cooler in 2002 compared to 2001. In 2001, temperature criteria used to evaluate emigration conditions were exceeded two to four weeks earlier (weekly average temperature exceeded 17.8ºC on April 22, weekly maximum temperature exceeded 20.5ºC on May 8, and 21.1ºC exceeded on May 15).

2.3.3.2 Seasonal water temperatures during the summer (June through September) rearing period.

Water temperatures were sub optimal for rearing juvenile steelhead from June through approximately mid September. Maximum daily average water temperatures within the Wohler Pool were ≥ 22.9ºC at all Wohler Pool sites during June and July, with a maximum daily temperature (bottom) of 26.3ºC recorded at Station 3 (Table 2-6). At Station #1, the weekly average temperature exceeded 17.8ºC between May 21 and June 27, the last day that data was recorded at this station (the hobo data logger was lost sometime after this date), and exceeded 20.0ºC from May 23 to the end of the data set (Tables 2-4 and 2-6). The weekly maximum temperature exceeded 22.0ºC (the temperature at which salmonids begin seeking cool water refuge) 16 times at Station #1, 27 times at Station #2, and 21 times at Station #5, respectively, during June 2002 (Table 2-6). Although temperatures appear to be cooler at Station #5 compared to Station #2, the weekly maximum and average temperatures were generally within ± 0.5ºC. Station #5 is deeper than Station #2, and may be slightly insulated from increases in daily temperatures, which may account for the slightly cooler temperatures. Hourly temperatures peaked at Station #2 and #3 at 26.0ºC, and 26.3ºC, respectively, for two hours on July 10. Temperatures in this range are approaching lethal levels.

2.3.3.3 Water temperature conditions during the fall adult migration period.

Water temperatures were sub optimal during the first three to four weeks during the adult upstream migration period (September). Average weekly temperatures exceeded 17.8ºC at Station #6 through September 23 (Table 2-6). A similar decline in water temperature was recorded at Station #2 where the water temperature above the influence of the Wohler pool exceeded the 17.8ºC weekly average temperature criteria until September 23 as well). After this date, water temperatures were suitable for upstream migration. Water temperatures improved rapidly starting the second week of October, with weekly average temperatures falling below 15.0ºC on October 21 (Tables 2-7 through 2-10).

Table 2-3. Maximum daily average, daily maximum, maximum weekly average, and maximum weekly maximum temperatures, by month, at 7 water temperature monitoring stations, Wohler Pool, 2002.

Maximum Daily Average Temperature (by month) (°C)							
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**
April 6	18.3	18.5	DLF[3]	18.8		18.8	18.8
May	22.0	22.2	DLF	22.6		22.6	22.6
June	21.9	22.9	DLF	23.3	23.0	23.5	23.8
July	NR[1]	23.4	23.7	23.8	24.0	24.0	24.3
August	NR	21.0	DLF	DLF	21.7	21.8	22.2
September	NR	20.0	20.3	20.3	20.3	20.5	20.8
October	N/S[2]	N/S	N/S	N/S	NS	17.8	NS
November	N/S	N/S	N/S	N/S	NS	13.9	NS

Daily Maximum Temperature (by month) (°C)							
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**
April 6	20.2	20.2	DLF	20.6	NS[3]	20.6	20.2
May	24.4	24.0	DLF	23.6	NS	23.2	24.4
June	24.4	25.6	DLF	25.6	23.6	24.0	25.6
July	NR	26.0	26.3	25.6	24.4	24.4	26.7
August	NR	23.2	DLF	DL	22.1	22.1	24.4
September	NR	22.5	22.1	22.1	20.9	21.0	22.9
October	NS	NS	NS	NS	NS	18.3	N/S
November	NS	NS	NS	NS	NS	14.5	N/S

Maximum Weekly Average Temperature (by month) (°C)							
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**
April 6	16.9	17.0	DLF[2]	17.3	N/S[3]	16.5	17.2
May	21.1	21.2	DLF[2]	21.7	N/S[3]	21.8	22.0
June	21.0	22.4	DLF[2]	22.8	22.9	23.0	23.3
July	NR[1]	22.6	22.8	23.1	23.2	23.3	23.6
August	NR[1]	20.5	DL[2]	DL[2]	21.0	21.2	21.5
September	NR[1]	18.9	19.1	19.1	19.4	19.5	19.7
October	NS	NS	NS	NS	NS	17.3	N/S
November	NS	NS	NS	NS	NS	13.7	N/S

Maximum Weekly Maximum Temperature (by month) (°C)							
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**
April 6	18.7	18.7	DLF[2]	18.7	N/S[3]	18.1	18.0
May	23.3	23.2	DLF[2]	23.1	N/S[3]	22.6	23.2
June	23.1	24.6	DLF[2]	24.7	23.5	23.5	25.1
July	NR	24.9	25.1	25.0	23.7	23.7	25.7
August	NR	22.5	DL[2]	DL[2]	21.5	21.5	23.6
September	NR	21.1	20.8	20.8	19.8	19.8	21.5
October	NS	NS	NS	NS	NS	17.8	N/S
November	NS	NS	NS	NS	NS	14.1	N/S

[1] NR = Data logger not recovered at end of season
[2] NS = No data collected
[3] DLF = Data logger failed

Table 2-4. **Number of times that the weekly average bottom temperature exceeded 17.8ºC, by month[1] at Stations #1 through #5 and #7, May through October, 2002.**

Stations	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
1 launched 3/3	0	16	21	DLF[3]	DLF	DLF	DLF	NS	NS
2 launched 4/6	NS[2]	0	17	30	31	31	22	NS	NS
3 launched 6/28	NS	NS	NS	NS	31	DLF	22	NS	NS
4 launched 4/6	NS	0	23	30	31	DLF	22	NS	NS
5 launched 6/1	NS	NS	NS	30	31	31	22	NS	NS
6 launched 3/9	0	0	10	30	31	31	23	0	0
7 launched	NS	0	22	30	31	31	23	NS	NS

Table 2-5. **Number of times that the weekly average bottom temperature exceeded 20.0ºC, by month[1] at Stations #1 through #5, and #7, May through October 2002.**

Stations	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
1	NS	0	7	17	DLF	DLF	DLF	NS	NS
2	NS	0	7	27	30	8	0	NS	NS
3	NS	NS	NS	NS	31	DLF	0	NS	NS
4	NS	0	8	30	31	2	0	NS	NS
5	NS	NS	NS	30	31	14	0	NS	NS
6	0	0	4	30	31	16	0	0	0
7	NS	0	8	30	31	22	0	NS	NS

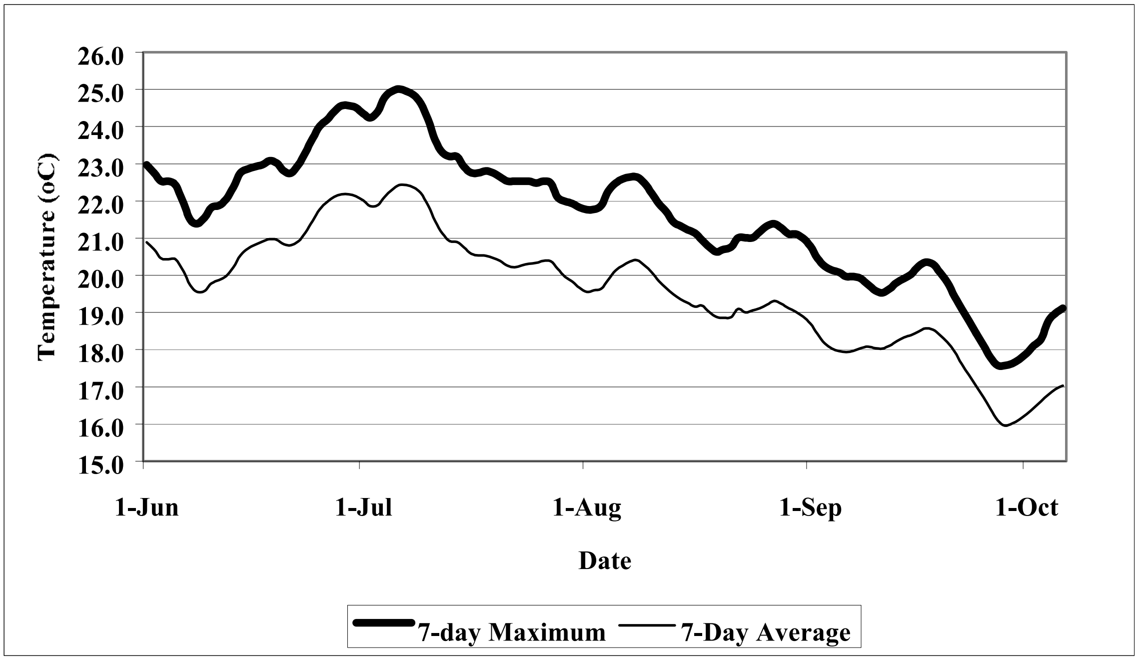
Table 2-6. **Number of times that the weekly maximum weekly bottom temperature exceeded 22.0ºC, by month[1], at Stations #1 through #5, and #7, May through October, 2002.**

Stations	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
1	NS	0	8	16	DLF	DLF	DLF	NS	NS
2	NS	0	3	27	28	7	0	NS	NS
3	NS	DLF	DLF	DLF	30	DLF	0	NS	NS
4	NS	0	7	24	28	DLF	0	NS	NS
5	NS	N/S	N/S	21	15	0	0	NS	NS
6	0	0	3	24	15	0	0	0	0
7	NS	0	5	30	31	14	0	NS	NS

Table 2-7. **Number of times that the daily maximum bottom temperature exceeded 24.0ºC, by month[1], at Stations #1 through #7, May through October, 2002.**

Stations	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
1	NS	0	0	0	DLF	DLF	DLF	NS	NS
2	NS	0	0	6	10	0	0	NS	NS
3	NS	DLF	DLF	DLF	10	DLF	0	NS	NS
4	NS	0	0	6	10	DLF	0	NS	NS
5	NS	N/S	N/S	0	0	0	0	NS	NS
6	0	0	0	0	0	0	0	0	0
7	NS	0	0	7	13	0	0	NS	NS

[1]Includes the first week of the following month (e.g. the 7-day average temperature for June 29th would extent through July 5th).
[2]NS = No sampled
[3]DLF = Data logger failed



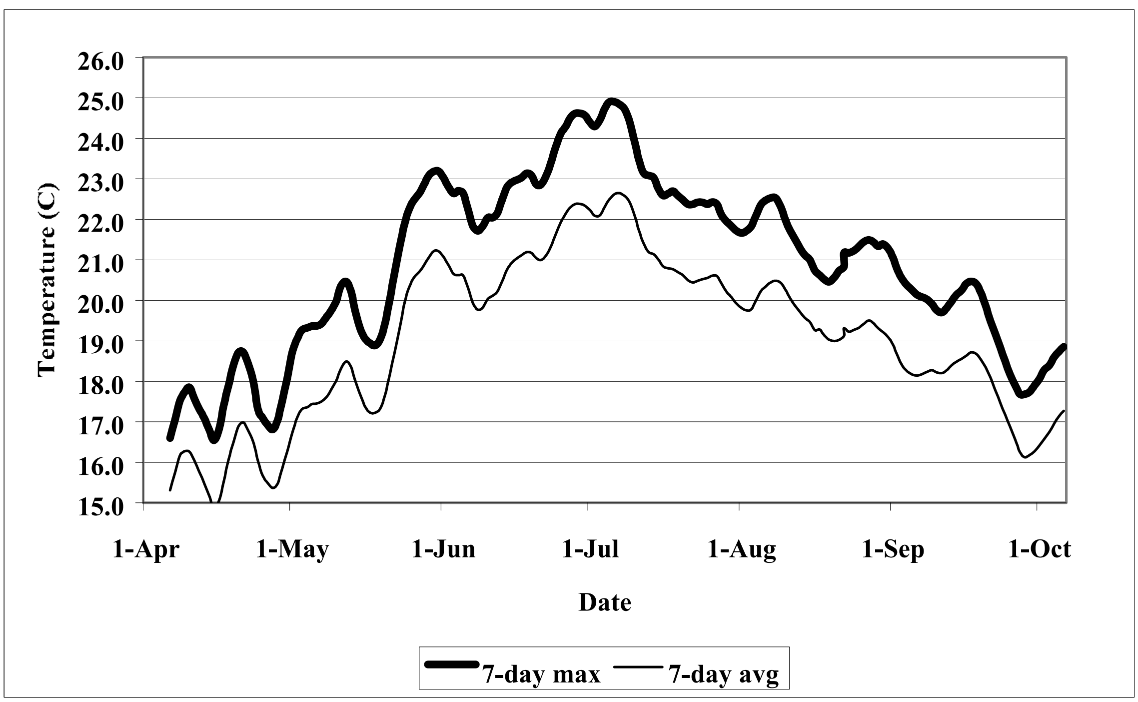
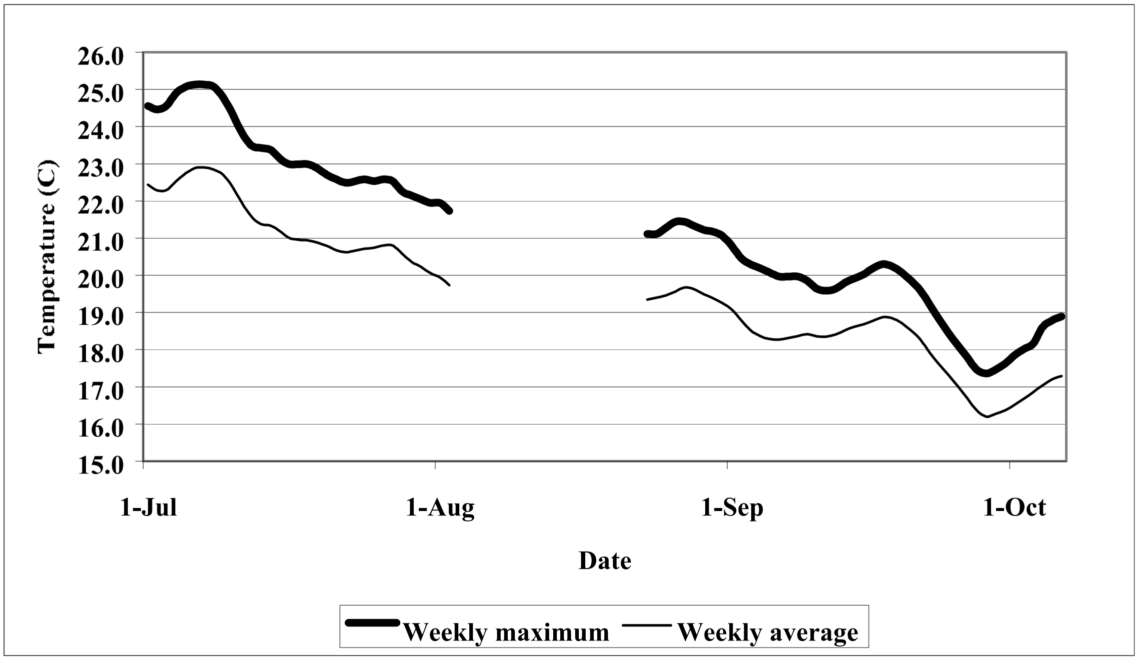


Figure 2-2 **Weekly maximum and weekly average water temperatures recorded at a depth of 0.5 meters (top figure) and 3.0 meters (bottom figure), Station #2, Mirabel Study Area, Russian River, 2002.**



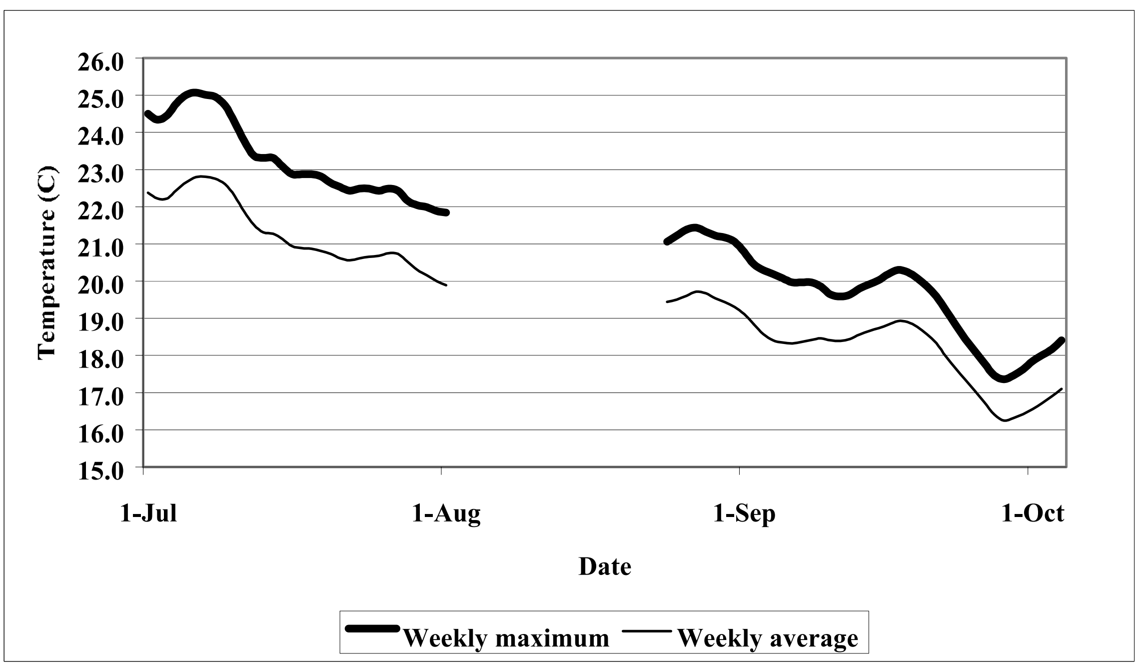
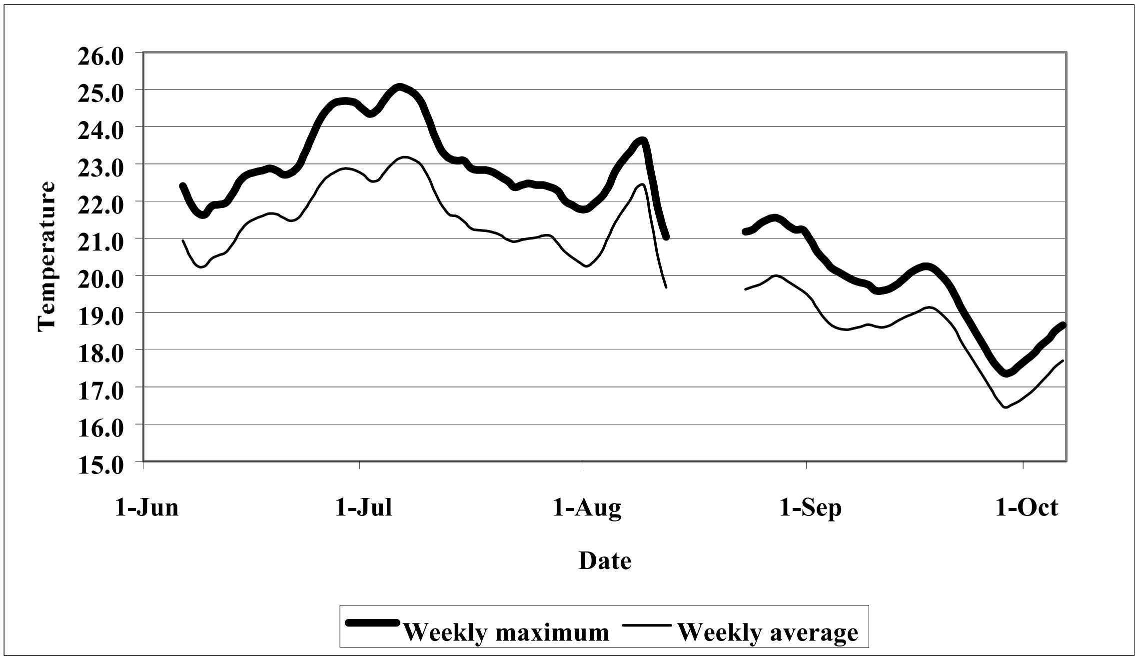


Figure 2-3 **Weekly maximum and weekly average water temperatures recorded at a depth of 0.5 meters (top figure) and 4.0 meters (bottom figure), Station #3, Mirabel Study Area, Russian River, 2002.**



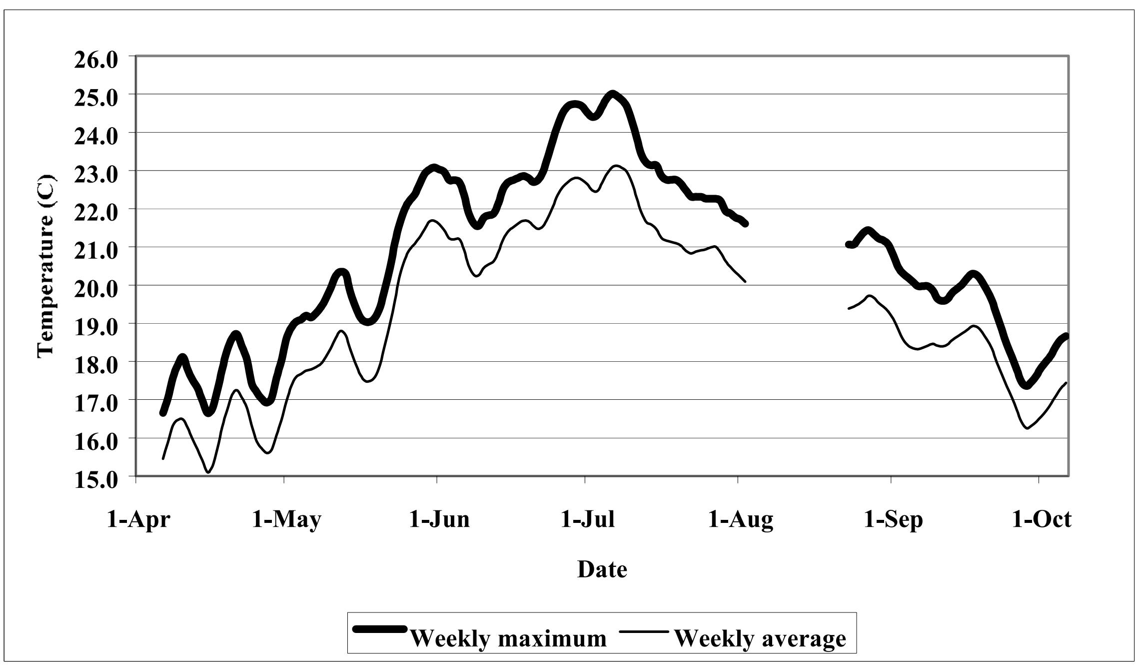
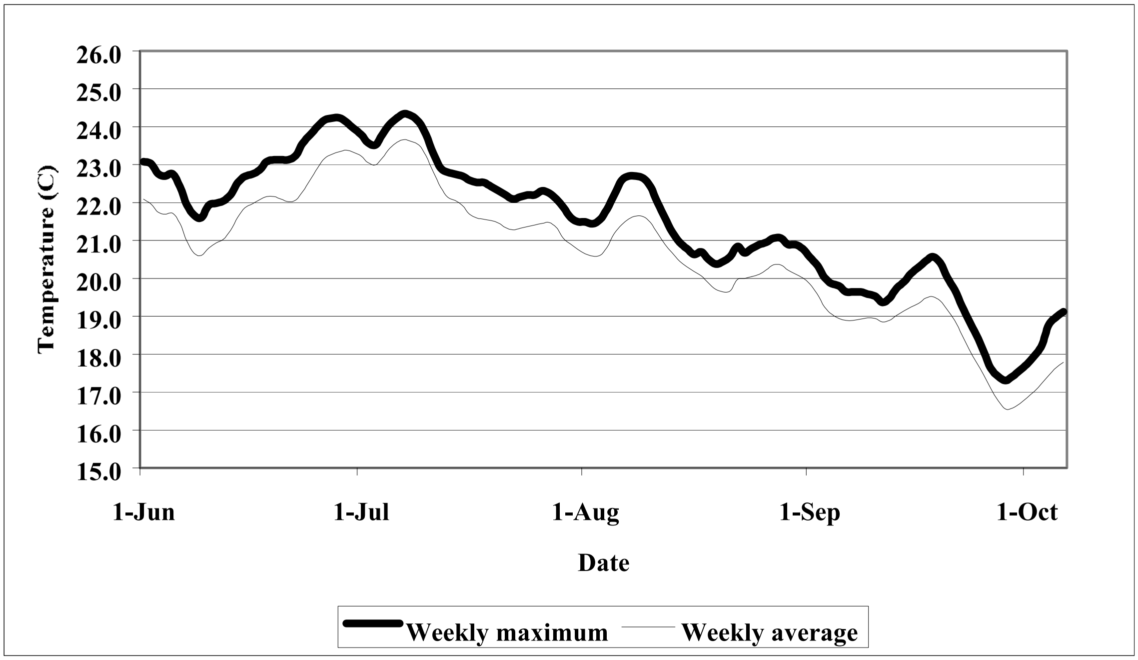


Figure 2-4 **Weekly maximum and weekly average water temperatures recorded at a depth of 0.5 meters (top figure) and 3.0 meters (bottom figure), Station #4, Mirabel Study Area, Russian River, April 26 through November 4 2002.**



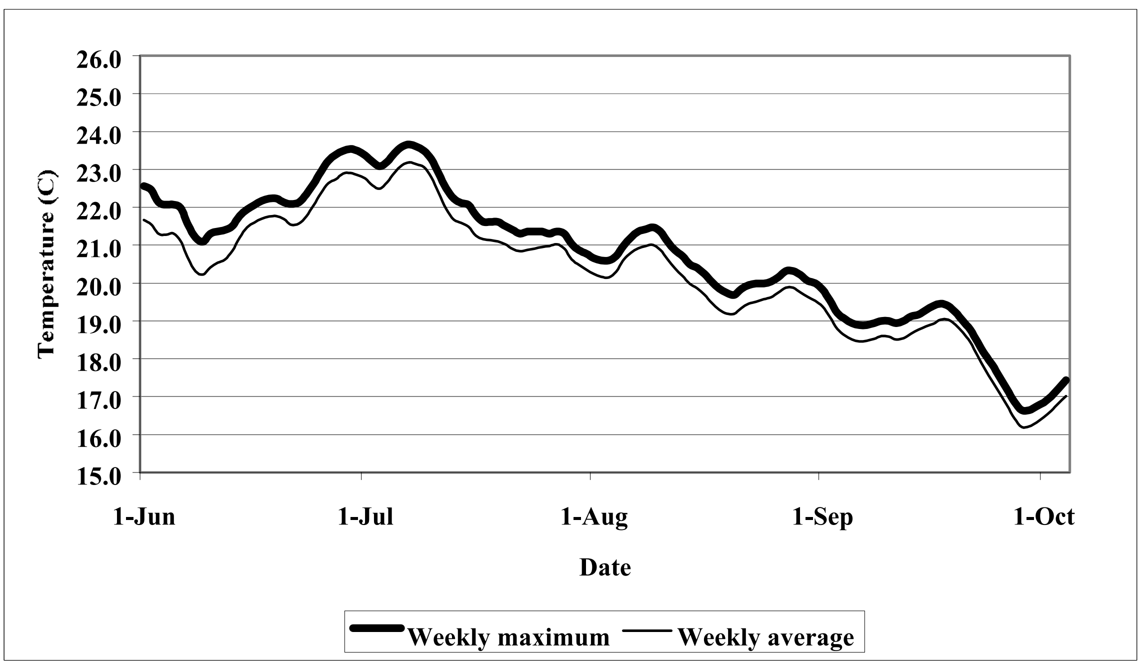


Figure 2-5. **Weekly maximum and weekly average water temperatures recorded at a depth of 0.5 meters (top figure) and 3.0 meters (bottom figure), Station #5, Mirabel Study Area, Russian River, 2002.**

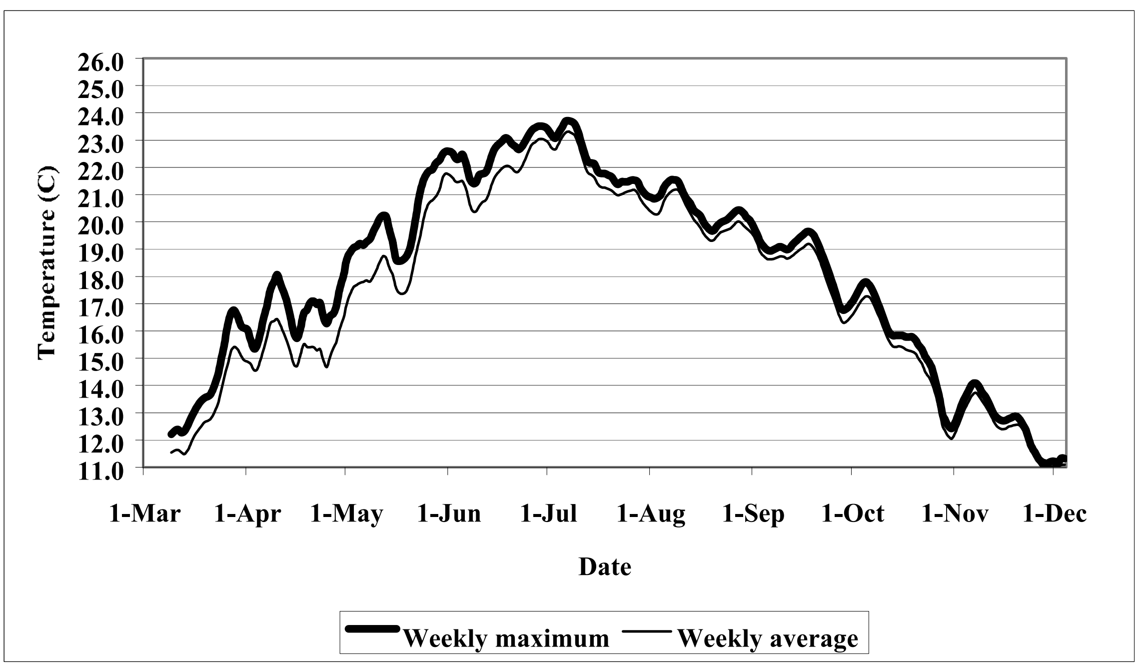
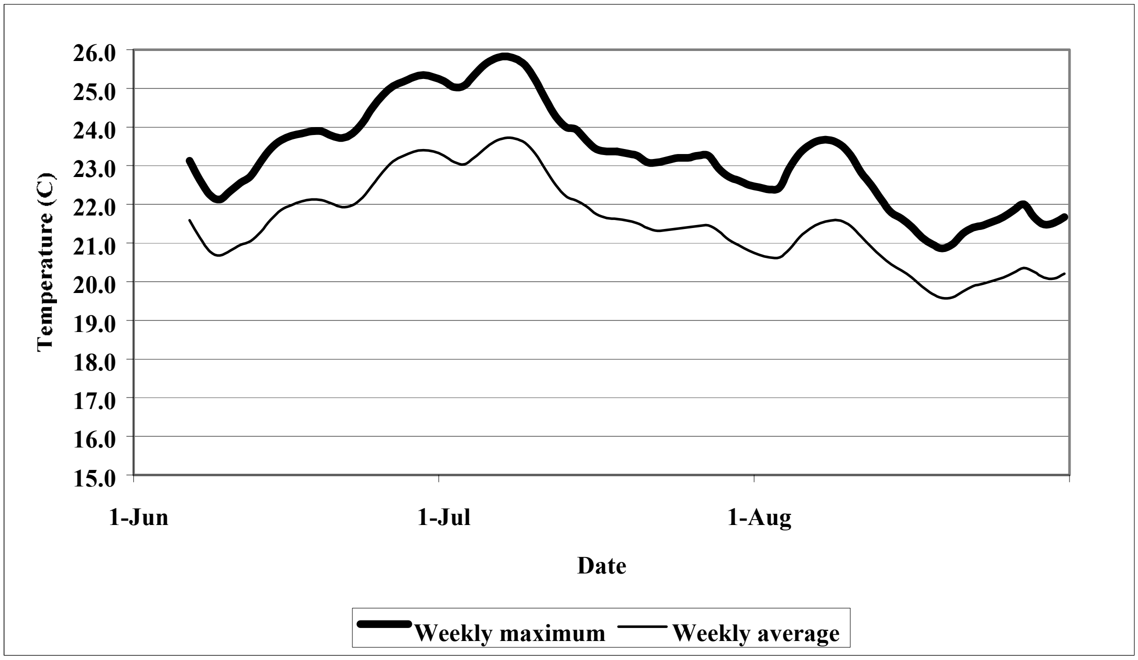


Figure 2-6. **Weekly maximum and weekly average water temperatures recorded at a depth of 2.0 meters, Station #6, Mirabel Study Area, Russian River, 2002.**



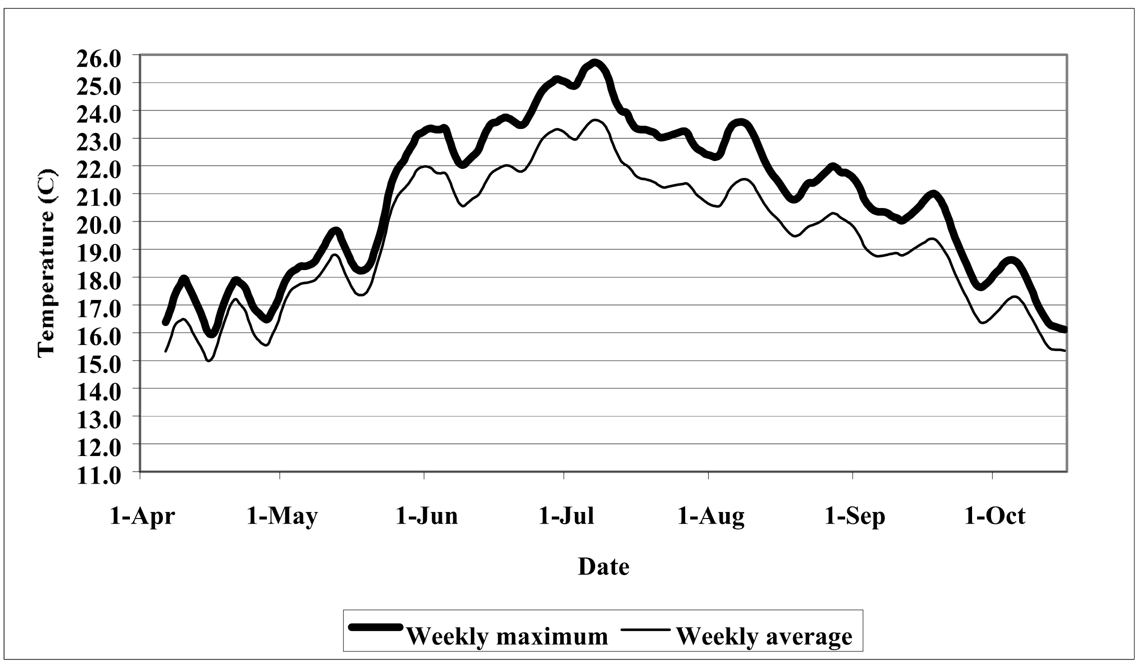


Figure 2-7. Weekly maximum and weekly average water temperatures recorded at a depth of 0.5 meters (top figure) and 2.0 meters, Station #7, Mirabel Study Area, Russian River, 2002.

2.4 WATER TEMPERATURE PROFILES

Water profiles were collected on eight occasions between June 5 and September 18, 2002 (Table 2-11). Dissolved oxygen profiles were collected during the first 3 sampling events before the DO probe malfunctioned. The Wohler Pool did not become thermally stratified during the 2002 sampling season, with the possible exception of Station 5 during the June profiles. Most of the difference in water temperature was observed in the upper 0.5 meters of the water column. The largest difference in temperature between the one-meter readings and the bottom (3.0 meter reading) was 1.4 and 1.3 °C during the June profiles. Surface temperatures were within 0.7 °C of the bottom temperatures (0.2 °C between the 1.0 meter and bottom readings) at the remaining stations.

Daytime dissolved oxygen (DO) levels ranged from 6.6 to 10.5 ppm (Table 2-11). Conductivity ranged from 203 to 261 μmhos (Table 2-11).

2.5 WATER TEMPERATURES AND FISH OBSERVATIONS

The above discussion of seasonal water temperatures provides an overview of the thermal conditions present during part of three different life history phases for Chinook salmon and steelhead. These observations, combined with the corresponding water temperatures, provide site-specific data relevant to the Russian River. However, to persist through time, a species must be able to survive, grow, and reproduce. Observations of fish at any particular time (and temperature regime) do not mean that they are meeting all of the above criteria. Observations of fish must be tempered by the fact that the present day thermal regimes in the river likely do not represent natural (historical) conditions and that although salmonids may be surviving under the present thermal regime, conditions may be sub optimal, and may negatively affect the long-term survival of these population levels of the three salmonid. Conversely, water temperature is only one of many factors that control fish populations in rivers. Populations may also be limited by factors unrelated to water temperature. Specific fish observations and water temperatures are discussed in related sections.

2.6 SIGNIFICANT FINDINGS

The main objective for this study could not be assessed in 2002 because of the loss of the data logger from Station #1. However, based on data collected in 2001, the Wohler Pool and the resulting impoundment appear to have a small influence on the rate at which water warms. Water flowing through the Wohler Pool was estimated to increase (in magnitude) from 0.1 (September) to 0.6ºC (June) above what would have been expected without the dam in place in 2001. The increase in the rate at which water warms within the Wohler Pool due to the presence of the impoundment had the effect of raising the average monthly surface water temperature from 20.6 to 21.2 in June, from 20.5 to 21.0 in July, from 20.3 to 20.6 in August, and from 18.6 to 18.7 in September of 2001.

Compared to proposed water temperatures standards for the Russian River, water temperatures in the study area were sub optimal for at least the last month of the smolt emigration period, the entire juvenile steelhead rearing period, and the beginning of the adult upstream migration period. The sub optimal conditions were similarly found above the influence of the impoundment, within the impoundment, and below the impoundment. Although the temperatures were often well above established temperature criteria, healthy appearing Chinook salmon and steelhead smolts were captured during periods when maximum daily surface temperatures ranged to 23.2ºC (see Section 3.0 for a detailed discussion of smolt emigration through the study area, including a comparison of water temperatures and smolts captured in the rotary screw traps). In addition, juvenile steelhead were captured and observed in the Wohler Pool throughout the summer months. Water temperatures were sub optimal during the first few weeks of the adult migration period, but steadily improved as the migration season progressed.

The shallow (approximately two to three meters) nature of Wohler Pool is not conducive to thermal stratification. As a result, the potential for the development of coldwater refugia in the Wohler Pool is low to non-existent under the conditions measured during the 1999 though 2002 sampling seasons.

Table 2-8. Water quality profiles data, Wohler Pool - Russian River, 2002.

Station #2								
Temperature								
Depth	**June 5**	**June 27**	**July 11**	**July 29**	**Aug 8**	**Aug 22**	**Sept 5**	**Sept 18**
0.1	24.6	21.1	24.5	22.8	22.7	20.1	19.4	20.1
0.5	24.6	21.1	24.4	22.8	22.7	20.1	19.5	20.1
1.0	24.6	21.1	24.4	22.7	22.7	20.1	19.5	20.1
2.0	24.6	21.2	24.4	22.6	22.7	20.0	19.5	20.1
2.5	24.6	21.2	24.4					
3.0				22.7	22.7	20.0	19.3	20.1
Dissolved Oxygen								
0.1	8.8	9.3	10.4	8.8	N/S[1]	N/S	N/S	N/S
0.5	8.4	8.7	9.9	8.4	N/S	N/S	N/S	N/S
1.0	8.7	8.3	10.2	8.7	N/S	N/S	N/S	N/S
2.0	8.6	7.7	10.5	8.6	N/S	N/S	N/S	N/S
2.5	8.7	7.6	9.9	8.7	N/S	N/S	N/S	N/S
3.0					N/S	N/S	N/S	N/S
Conductivity								
1.0	261.0	236	227	229	209	210	211	221

Station #3								
Temperature								
Depth	**June 5**	**June 27**	**July 11**	**July 29**	**Aug 8**	**Aug 22**	**Sept 5**	**Sept 18**
0.1	24.0	21.8	23.9	21.5	21.3	19.4	18.6	19.5
0.5	24.1	21.7	23.9	21.5	21.3	19.4	18.5	19.4
1.0	24.1	21.7	23.9	21.4	21.3	19.4	18.5	19.4
2.0	24.2	21.7	23.9	21.5	21.2	19.4	18.6	19.3
3.0		21.8		21.5	21.2	19.4	18.6	19.3
4.0				21.5	21.2	19.4	18.6	19.3
Dissolved Oxygen								
0.1	7.2	8.6	9.4	7.2	N/S	N/S	N/S	N/S
0.5	8.3	8.3	9.0	8.3	N/S	N/S	N/S	N/S
1.0	7.8	8.7	9.4	7.8	N/S	N/S	N/S	N/S
2.0	8.6	8.5	9.0	8.6	N/S	N/S	N/S	N/S
3.0		8.6			N/S	N/S	N/S	N/S
4.0					N/S	N/S	N/S	N/S
Conductivity								
1.0	258	235	228	229	204	211	213	223

N/S[1] = Not sampled

Table 2–11. Water quality profiles data, Wohler Pool - Russian River, 2002 (concluded).

Station #4								
Temperature								
Depth	**June 5**	**June 27**	**July 11**	**July 29**	**Aug 8**	**Aug 22**	**Sept 5**	**Sept 18**
0.1	24.2	22.7	24.3	21.7	21.0	19.3	18.6	19.6
0.5	24.2	22.4	24.1	21.7	20.8	19.3	18.5	19.4
1.0	24.1	22.2	23.9	21.7	20.8	19.3	18.5	19.4
2.0	24.0	22.1	23.8	21.7	20.7	19.3	18.5	19.4
3.0	24.0	22.0	23.7	21.7	20.8	19.3	18.5	19.5
Dissolved Oxygen								
0.1	7.8	8.3	8.5	N/S	N/S	N/S	N/S	N/S
0.5	7.7	7.7	8.7	N/S	N/S	N/S	N/S	N/S
1.0	8.6	7.2	8.5	N/S	N/S	N/S	N/S	N/S
2.0	8.7	7.3	8.7	N/S	N/S	N/S	N/S	N/S
3.0	7.8	6.7	8.6	N/S	N/S	N/S	N/S	N/S
Conductivity								
1.0	261	236	224	213	203	211	213	223

Station #5								
Temperature								
Depth	**June 5**	**June 27**	**July 11**	**July 29**	**Aug 8**	**Aug 22**	**Sept 5**	**Sept 18**
0.1	24.6	24.5	26.1	21.4	22.3	20.3	20.9	21.1
0.5	24.2	22.5	24.8	21.4	21.8	20.2	19.7	20.2
1.0	24.1	21.7	24.3	21.4	21.5	19.5	19.5	19.6
2.0	23.2	21.3	24.0	21.4	21.2	19.3	19.3	19.5
3.0	22.8	21.2	24.1	21.3	21.6	19.5	19.4	19.5
Dissolved Oxygen								
0.1	8	7.3	7.8	N/S	N/S	N/S	N/S	N/S
0.5	8.3	7.9	9.2	N/S	N/S	N/S	N/S	N/S
1.0	8.3	8.3	8.8	N/S	N/S	N/S	N/S	N/S
2.0	73.0	8.4	9.0	N/S	N/S	N/S	N/S	N/S
3.0	6.8	8.5	8.8	N/S	N/S	N/S	N/S	N/S
Conductivity								
1.0	261	233	236	201	205	203	213	220

3.0 SMOLT EMIGRATION

The impoundment formed by the Inflatable Dam can potentially impact juvenile salmonids as they migrate to the ocean. When in place, the Inflatable Dam impounds water upstream approximately 5.1 km. Emigrating salmonid smolts swim or drift downstream with the current. The impoundment decreases current velocities, and the smolts may become disoriented by the loss of the tactile stimulus provided by moving water. Smolts may be delayed or unable to find their way downstream of the dam. Smolts have a seasonal "window of opportunity" to complete the physiological process (smoltification) necessary to survive in the marine environment. A substantial delay in migration may result in smolts reverting to a "resident form," thus spending an additional year in freshwater. Depending on summertime conditions, this may greatly increase mortality of smolts failing to successfully migrate to the ocean. Of equal importance, the dam itself may impede smolt passage by forming a barrier to downstream movement.

Two sampling strategies (rotary screw traps and radio-telemetry) were employed to collect data on emigrating smolts. Rotary screw traps were used to capture fish as they migrated past the trapping site (60 m downstream of the dam). Trapping data provides information on species composition, timing of emigration (past a particular point on the river), allows for the collection of size and age data, plus the collection of tissue for DNA sequencing. Tissue samples collected during the study are provided to the NMFS for analysis and reporting. A mark-recapture study was also initiated in April (when the smolts became large enough to mark) to estimate the number of Chinook salmon smolts emigrating past the dam. Radio-telemetry provides information on the rate of emigration of hatchery steelhead smolts through the Wohler Pool, and their success at passing the dam when it is inflated, as well as providing some insight into the fate of those that did not pass the dam. The results of the radio-telemetry program are presented in a companion study (Manning *et al* 2001, Manning *et al.* 2003).

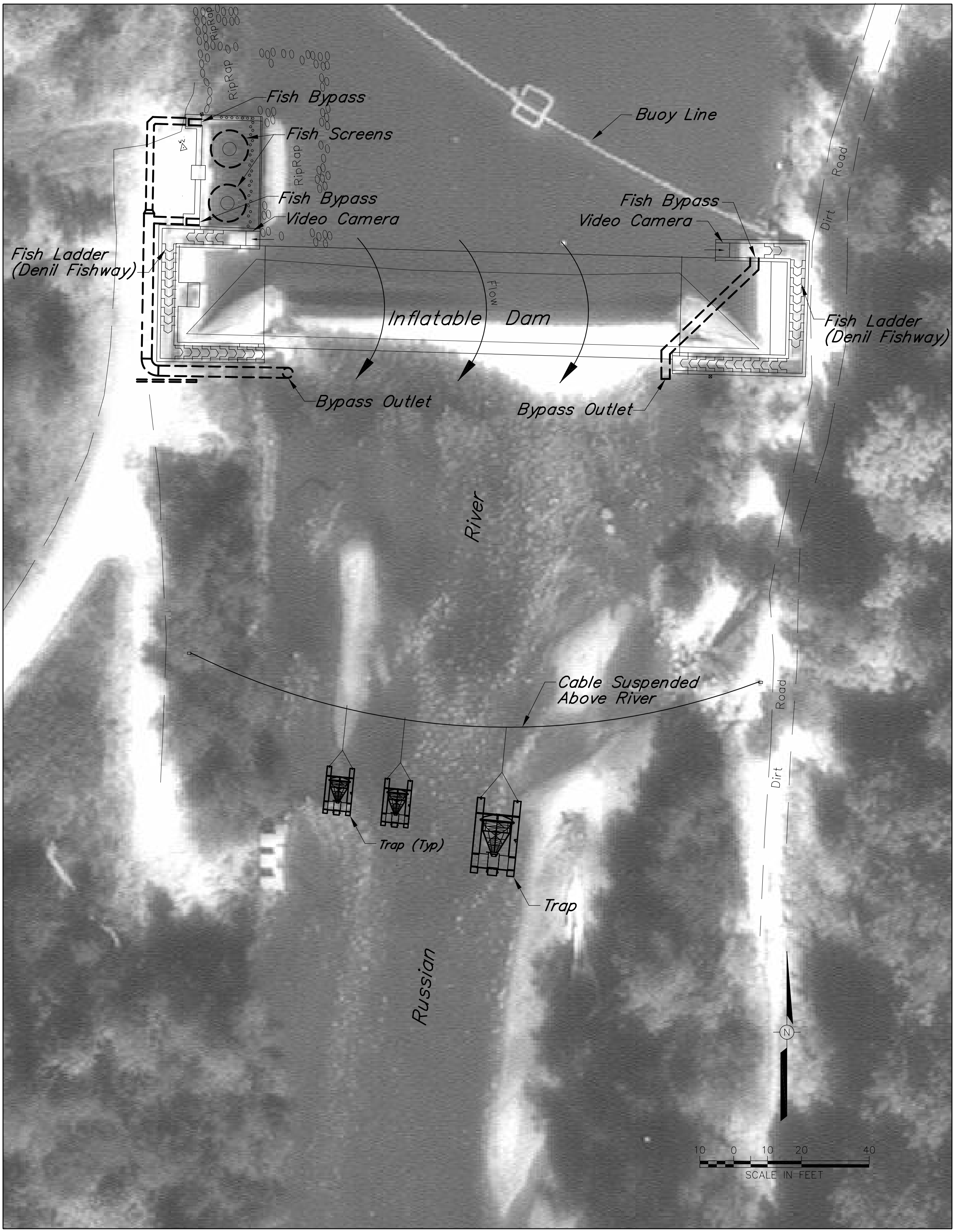
3.1 METHODS

3.1.1 Rotary Screw Trap

Rotary screw fish traps consist of a cone of perforated stainless steel panels which houses an internal Archimedes screw assemblage. Water striking the angled surface of the internal screw rotates the cone and screw assembly. As the assembly rotates, fish are trapped within the chambers formed by the screw and moved rearward into the live box at the back of the trap. The live box is constructed such that areas of very low water velocity are provided as resting areas for fish held in the box. Debris such as leaves and small twigs entering the live box are impinged on a rotating debris screen located at the back of the live box. As the screen rotates, debris is carried out of the box, maintaining a relatively clean environment for the fish held in the live box. The cone is mounted between two pontoons and is lowered and raised with a bipod and windlass located at the front of the cone. Rotary screw traps are lowered into the water column until half of the cone is submerged (an 8-foot diameter trap requires a minimum depth greater than 4.0-feet to operate).

The rotary screw trap site is located approximately 60 m downstream of the Inflatable Dam (Figure 3-1). Rotary screw traps are designed to capture downstream migrating juvenile fish (Figure 3-2). The screw traps are generally fished in the main channel where the water velocities are highest and the water column is the deepest (thalweg) since emigrating smolts are likely to be concentrated in these areas. Maintaining the trap in the desired location within the channel required a series of cables secured to the shoreline.

The cable infrastructure and support system consisted of an anchor and a series of cables to maintain the trap in place as well as to move the trap across the channel. The cable system was anchored to two 30-foot by 10-inch H-beam piles driven approximately 27-feet (vertically) into the riverbank directly parallel from each other. The cabling system consisted of four components; the main line, the bridle, the lateral adjustment cable, and the visual barrier support cable.



DATE OF PHOTOGRAPHY: SEPT 30, 1999

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SONOMA COUNTY WATER AGENCY

Figure 3–1 Plan view of rotary screw fish trap, video cameras, and fish passage structures at Inflatable Dam

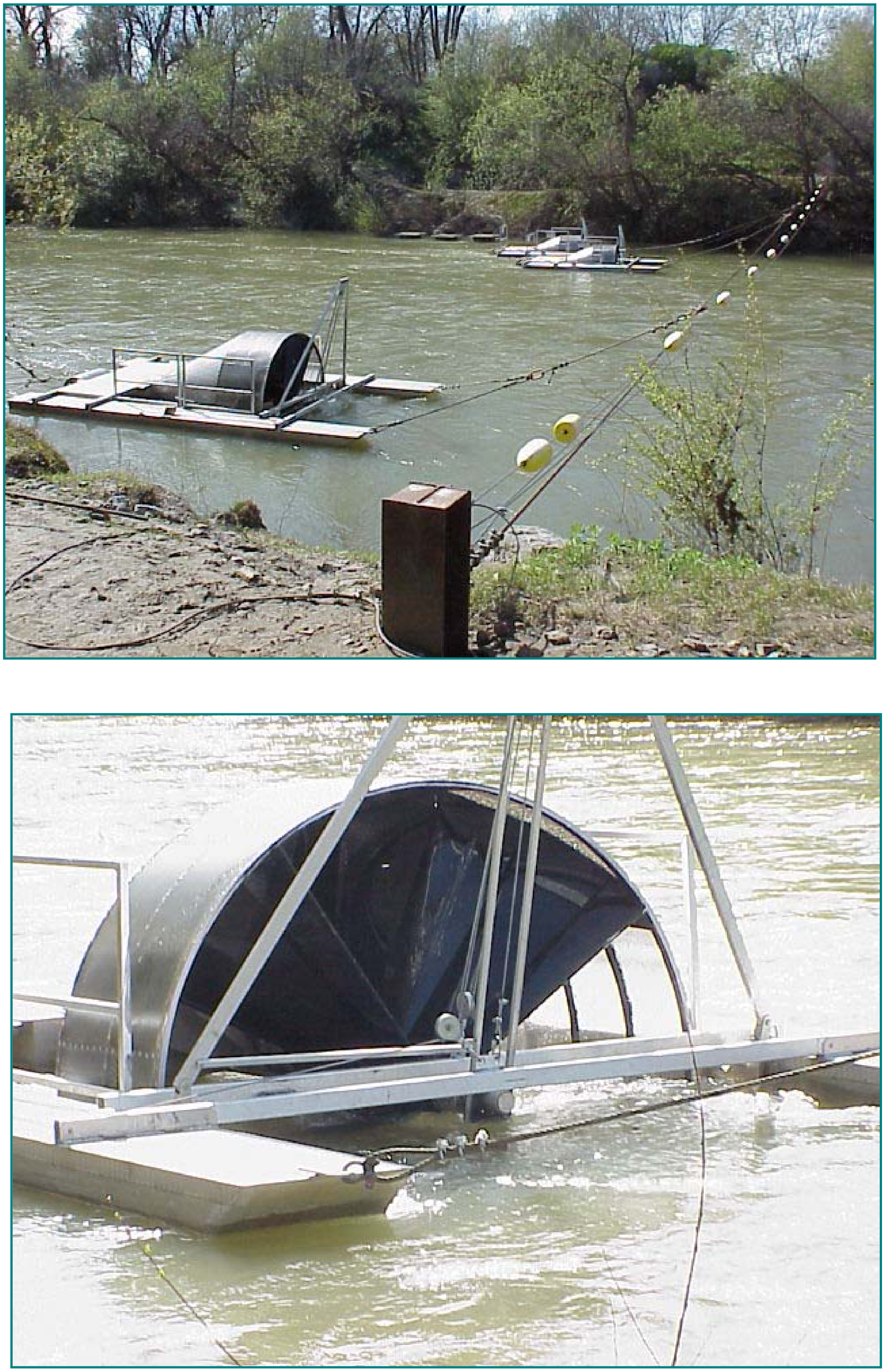

Figure 3-2. **Rotary Screw Traps (under relatively high flow conditions) in the Russian River below the Inflatable Dam.**

The main line consisted of a 170-foot long, 0.75-inch steel cable. The cable was pulled across the river, stretched tight, and secured to the piles with heavy equipment. The bridle consisted of a 20-foot length of 0.75-inch steel cable attached the rotary trap to the main line. The lateral adjustment cable consisted of a continuous length of 0.38 inch galvanized steel cable. The cable was run through two 4.0-inch blocks attached to the H-beam piles. The ends of the cable were attached to the block on the main line, creating a continuous loop (similar in theory to a clothes line). This looped cable was used to move the trap(s) into position and to adjust the trap(s) position when required. Once the trap was positioned appropriately, a cable clamp was used to secure the lateral cable in position. A 0.38-inch safety break-a-way cable was connected to the rear corner of the trap and to an anchor point on the shoreline.

Yellow floats were attached to a cable stretched across the river above the other cables. The floats were strung out along this cable at 10-foot intervals to provide a warning for boaters and low flying aircraft (e.g., helicopters) that an obstruction was placed across the river.

3.1.2 Operation of the Rotary Screw Fish Trap

Three rotary screw traps (two 5-feet in diameter and one 8-feet in diameter) were operated throughout the 2002 sampling season. The rotary screw traps were installed in the river on the afternoon of February 28 and fished through the morning of June 27. Fish captured by the screw traps were netted out of the live well and placed in an insulated ice chest (approximately 3.0’ X 2.0’) supplied with freshwater. Aerators were operated to maintain DO levels in the ice chest. Prior to data collection, fish were transferred to a five-gallon bucket containing water and Alka-seltzer, which was used as an anesthetic. Fish captured were identified to species, measured to the nearest mm (FL), scales were collected from wild steelhead smolts, and tissue samples (an approximately 1 mm^2 section clipped from the caudal fin) were taken from a sub sample of Chinook and steelhead smolts. After data collection, fish were placed in a bucket containing fresh river water. Dissolved oxygen levels in the recovery buckets were also augmented with aerators to insure that the DO level remained near saturation. Once equilibrium was regained, the fish were released into the river downstream of the screw traps.

3.1.3 Mark-Recapture Study

Beginning March 26, Chinook salmon captured in the trap were sub sampled, and up to 50 fish (depending on the number of fish captured) were marked with a caudal clip (identical to the clip used to collected tissue samples). Only Chinook salmon >60 mm FL were included in the marking process. Marked fish were held in container of water equipped with aerators, and transported and released approximately 0.8 km above the dam. The proportion of marked to unmarked fish captured in the traps was then used to calculate a weekly estimate of the number of Chinook smolts emigrating past the dam (Bjorkstedt 2000).

3.2 RESULTS

3.2.1 Rotary Screw Trapping Results

The capture of fish in the screw traps was influenced by the time of year, streamflow, and potentially whether the dam is inflated or deflated. Streamflow generally declined throughout the study, with few exceptions. The screw traps were operated from the afternoon of February 28 through the morning of June 27, excluding April 16, when the dam was inflated. The river configuration remained almost unchanged between 2001 and 2002 trapping seasons (an island formed in the river between the dam and the trapping location between the 2000 and 2001 trapping seasons. The split channels concentrate streamflow in to two relatively small channels (compared to conditions in 1999 and 2000), creating excellent conditions for fishing the screw traps). As a result, the trapping efficiencies in 2001 and 2002 were undoubtedly superior to those experienced during the 1999 and 2000 trapping seasons.

During the 2002 trapping season, 33,377 fish (excluding larval cyprinids and Sacramento suckers) including twenty-three species were captured Appendix E). Chinook smolts were the most abundant species collected, followed by young-of-the-year steelhead, threespine stickleback, and ammocoetes (immature lamprey).

3.2.2 Salmonids

3.2.2.1 Chinook salmon

Chinook smolts were captured throughout the trapping season (March 1 – June 25, 2002). The start of the trapping season appears to have coincided with the start of the Chinook salmon emigration season. Relatively few Chinook were captured during the first two weeks of sampling. Based on the weekly catch rates, it appeared that Chinook smolt emigration begins in late February, peaks mid April to mid May, and slowly declines through June (Table 3-1). For the season, 19,319 Chinook smolts were captured in the traps (Appendix E provides daily catch data for all species).

A mark-recapture study was initiated on March 26, continuing through June 9. During the study period, 2,804 Chinook smolts were marked with a caudal clip and released approximately 0.8 km upstream of the traps: 253 smolts were subsequently recaptured. Weekly capture efficiencies were developed for the 11-week period. Weekly capture efficiencies ranged from 14.3 percent to 2.5 percent during the study (Table 3-2). For the mark-recapture study period (all catch data combined), the capture efficiency was 9.0 percent. Estimates of smolt emigration past the trap ranged for the season was 215,875 between March 26 and June 9 (Table 3-2). Although Chinook began migrating past the dam prior to the start of the mark-recapture study, and continued to migrate at low numbers after the study ended, the vast majority of the run was encompassed during the mark-recapture study.

Water temperatures were recorded at Station 6 (dam) from March 9 through the end of smolt sampling. Based on a literature review conducted by Klamt et al. 2000, Chinook salmon should be fully protected at temperatures of 17.8°C or less, they exhibit positive growth at temperatures between 4.4 and 18.9°C, and are prevented from emigrating at 21.1°C, and have a daily maximum temperature of approximately 23.9°C. Weekly average water temperatures ranged from 11.5 to 22.9°C, and maximum daily temperatures ranged up to 24.4°C between March 9 and June 27, 2002 (Figure 2-5). During the peak Chinook smolt emigration period (last week in April first two weeks of May), the weekly average temperature ranged from 15.1 to 18.0°C, and the weekly maximum temperature ranged from 15.7 to 20.2°C (Figure 3-3). The weekly average water temperature first exceeded 17.8°C on May 7, exceeded 18.9°C on May 23, and exceeded 21.1°C on May 29. The percentage of total number of Chinook smolts that past the dam prior to these dates are 65.7, 86.9, and 95.3, respectively. Chinook fingerlings migrate seaward between April and June (Healy 1998). Although Chinook numbers in the traps declined as the weekly average temperature increased above 18.0°C, the reduction in the Chinook catch was gradual, and the seasonal catch rate followed a bell shaped curve, suggesting that the run declined naturally.

The average size of Chinook smolts captured in the screw trap increased from 38 mm FL during the first week of sampling to 91 mm FL during the last full week of sampling (Table 3-3). Individual Chinook smolts ranged in length from 29 to 118 mm FL throughout the 2002 sampling period.

Table 3-1. Weekly salmonid catch in the rotary screw trap, 2002 sampling season.

Week	Chinook	Wild steelhead smolts	Steelhead parr	Young-of-the-year steelhead	Hatchery steelhead
26-Feb	45	1	0	0	9
5-Mar	74	1	0	0	50
12-Mar	319	38	0	1	876
19-Mar	181	14	2	6	409
26-Mar	797	24	0	3	25
2-Apr	908	30	2	55	20
9-Apr	757	33	0	51	296
16-Apr	2,279	31	3	447	72
23-Apr	2,992	25	0	81	41
30-Apr	4,337	23	1	657	13
7-May	1,780	8	1	755	2
14-May	2,056	8	1	976	5
21-May	1,755	9	0	1,315	5
28-May	704	2	0	806	2
4-Jun	192	0	1	466	0
11-Jun	93	1	2	164	0
18-Jun	46	1	2	59	0
25-Jun	4	0	0	1	0
Total	**19,319**	**249**	**15**	**5,843**	**1,825**

Table 3-2. Results of the Chinook smolt mark-recapture study, spring 2002.

Week of	Smolts marked	Smolts recaptured	Weekly efficiency	Actual catch	Seasonal estimate
26-Mar	116	14	12.1	708	
2-Apr	187	25	13.4	908	
9-Apr	249	25	10.0	756	
16-Apr	182	15	8.2	2279	
23-Apr	321	46	14.3	2992	
30-Apr	352	44	12.5	4337	
7-May	332	19	5.7	1778	
14-May	340	25	7.4	2057	
21-May	280	28	10.0	1755	
28-May	275	7	2.5	704	
4-Jun	170	5	2.9	174	
Seasonal Total	**2,804**	**253**	**9.0**	**18,448**	**215,875**

Table 3-3. Weekly minimum, average, and maximum lengths of Chinook salmon smolts captured in the rotary screw trap, 2002 sampling season.

Week of	Number	Minimum length	Average length	Maximum length
March 1-March 4	45	34	38	56
March 5 - March 11	74	33	41	58
March 12 - March 18	319	29	51	72
March 19 - March 25	179	38	57	75
March 26 - April 1	793	38	60	84
April 2 - April 8	895	35	65	97
April 9 - April 15	746	35	73	108
April 16 - April 22	2,191	36	80	118
April 23 - April 29	2808	46	82	118
April 30 - May 6	1,369	40	82	111
May 7 - May 13	1,396	50	84	109
May 14 - May 20	1,030	55	84	112
May 21 - May 27	736	51	87	111
May 28 - June 3	687	49	84	104
June 4 - June 10	196	59	85	109
June 11 - June 17	91	50	86	112
June 18 - June 24	46	74	91	113
June 25 - June 27	4	69	83	103

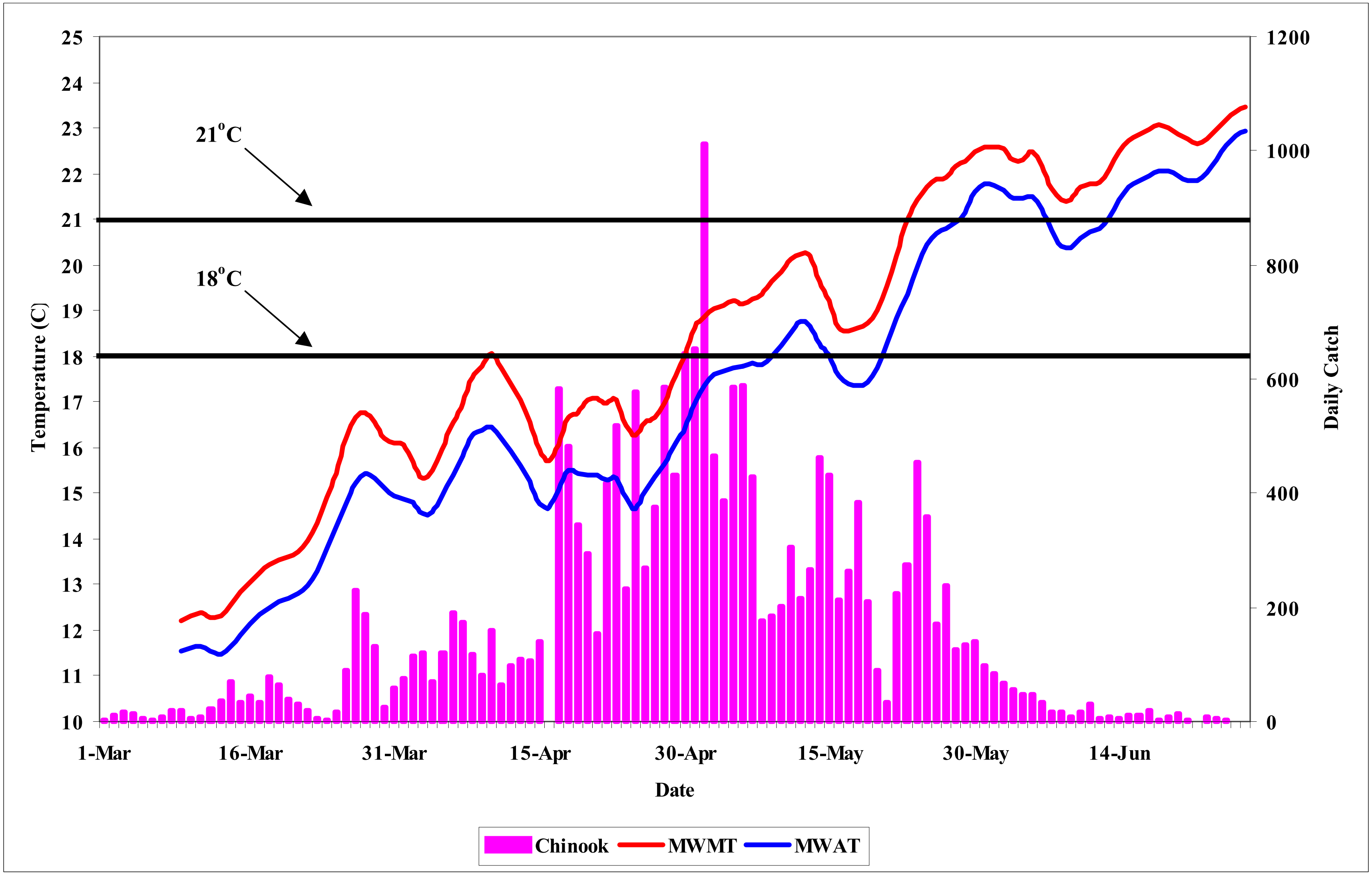

Figure 3-3 **Chinook salmon catch in rotary fish screw trap and water temperature, Russian River at Mirabel, 2002.**

3.2.2.2 Juvenile Steelhead:

Steelhead smolts were captured throughout the trapping season, but at lower numbers than Chinook smolts. Wild steelhead smolts in the Russian River emigrate primarily as 2-year-old fish. Scale samples were collected from 291 wild steelhead captured in the screw traps. Of these, 69 were aged as Age 0+, 13 were aged as Age 1+, 159 were aged as Age 2+, and four were aged as Age 3+ (43 scale samples were unreadable due to re-absorption of scale tissue). Based on the lengths of aged fish, ages were assigned to all steelhead captured in the screw trap using both fish of known age (scales) and length frequency histograms. Since fish were captured over a three-month period, fish were grouped based on date of capture (one-week intervals). The steelhead captured were produced in several different streams in the upper basin; each stream with potentially different rearing conditions. Thus, steelhead from one stream may be considerably larger than steelhead of the same age rearing in a different stream. In 2002, 6,102 steelhead were captured; including 5,843 YOY, 14 Age 1+ parr, 243 Age 2+ smolts, and 6 Age 3+ smolts. Age 0+ steelhead ranged in length from 25 to 125 mm FL (Table 3-5). Age 1+ fish ranged in length from 98 to 148 mm FL. Fish aged as one-year-old generally did not posses the characteristics associated with "smolting" fish (e.g., body shape and bright silver coloration), and may not have been ocean bound emigrants. Age 2+ smolts ranged in length from 145 to 227 mm FL, and the Age 3+ smolts ranged in length from 198 to 240 mm FL (Figure 3-4, Table 3-6).

Table 3-5. Weekly catch and size range (mm) of young-of-the-year steelhead captured in the screw trap, 2002

Week of	N	Minimum	Average	Maximum
26-Feb	0			
5-Mar	0			
12-Mar	1	29	29.0	29
19-Mar	6	25	33.7	39
26-Mar	3	25	35.0	40
2-Apr	0	24	37.7	47
9-Apr	51	24	43.2	62
April 16	428	23	40.9	78
April 23	80	26	46.6	75
April 30	577	25	48.6	81
May 7	701	23	52.2	89
May 14	574	28	58.9	96
May 21	705	30	705	118
May 28	383	32	65.9	118
June 4	456	28	66.1	111
11-Jun	156	38	69.2	118
18-Jun	58	36	81.2	121
25-Jun	1	125	125.0	125

Table 3-6. Weekly average, minimum and maximum lengths of steelhead smolts captured in the screw trap, 2002

Week of	N	Minimum	Average	Maximum
26-Feb	1	222	222.0	222
5-Mar	1	190	190.0	190
12-Mar	38	160	186.0	223
19-Mar	14	147	172.7	214
26-Mar	24	151	186.1	239
2-Apr	30	146	176.8	240
9-Apr	33	148	187.2	233
April 16	31	152	179.1	205
April 23	25	153	181.6	226
April 30	23	160	178.5	208
May 7	8	154	170.6	193
May 14	8	166	185.1	200
May 21	9	163	173.6	188
May 28	2	176	188.0	180
June 4	0	--	--	--
11-Jun	1	152	152.0	152
18-Jun	1	155	155	155
25-Jun	0	--	--	--

3.3 SIGNIFICANT FINDINGS

Rotary screw traps have been operated primarily during the second half of the spring emigration period during the first three years of this study (1999-2001). In 2002, the traps were operated throughout the majority of the emigration period for the first time (March 1 though June 27). Since several operational factors vary between years (time of year that the traps are operated, size and number of traps deployed, and the efficiency of the traps), it is not possible to make direct comparisons between sampling seasons. Still, a few preliminary conclusions can be drawn from the data collected to date.

The beginning of the Chinook salmon downstream migration period was documented for the first time in 2002. Chinook salmon were captured in low numbers in the traps on March 1 (indicating that Chinook first start to emerge from the gravel in late February). The catch of Chinook smolts slowly increased during March and early April, peaked during the last two week in April and first two week in May, then slowly declined through the end of June. The timing of the Chinook emigration period in 2002 followed a similar pattern to the previous years data. Smolts were captured as late as June 25 in 2002, and June 27 in 2000 (although low numbers of smolts were still being captured when sampling ended).

The size of the Chinook smolt run was estimated over a five-week period in 2001, and over an 11-week period in 2002. In 2001, 20,245 Chinook smolts were estimated to have emigrated past the dam between May 3 and June 4. During 2002, an estimated 94,172 Chinook smolts were passed the dam during the same period. Between March 26 and June 4, 2002, an estimated 215,875 Chinook smolts were estimated to have emigrated past the traps.

Wild steelhead smolts are less likely to be captured in the rotary screw traps compared to Chinook smolts. Steelhead emigrate at a much larger size, and are stronger swimmers (based on size) and may be less likely to be captured, particularly by the 5-foot traps. Steelhead smolts were captured throughout the trapping season, but at lower numbers than Chinook smolts. For the season, 249 wild steelhead smolts were captured in the rotary screw trap (Table 3-1). Steelhead smolts were captured primarily in mid March through April, with the run extending through May. Wild steelhead smolts in the Russian River emigrate primarily as 2-year-old fish.

The capture of Chinook and wild and hatchery steelhead smolts after inflation indicates that the dam is not a complete barrier to migration. Previous studies suggest that the dam may delay passage around the dam of at least some hatchery steelhead smolts. The magnitude could not be determined by the current study. A companion study, Manning *et al.* (2000 and 2003), was instituted to define the potential impacts of the dam on steelhead smolts. Chinook smolt emigration through the study area did not appear to be delayed by the dam. As part of the mark-recaptured study instituted to estimate Chinook smolts abundance, Chinook smolts were marked with an alternating upper and lower caudal (tail) clip on a weekly basis, then transported approximately 0.8 km upstream of the dam. On the day following a change in the clip used, Chinook smolts captured in the screw traps almost invariably possessed the new clip. Few Chinook smolts were recaptured bearing the previous weeks clip, which would indicate that they had required more than 48 hours to pass the dam. Chinook smolts are two to four months old at the time of emigration, and are much smaller than steelhead smolts that emigrate as two-year-olds. The smaller sized Chinook smolts maybe better at passing over the dam compared to the larger steelhead smolts.

This study provides valuable insight into the run timing of Chinook and wild steelhead smolts. This information defines the period when salmonid smolts are most likely to encounter the dam, and will be used to manage the Inflatable Dam to minimize impacts to listed species.

4.0 WOHLER POOL FISH COMUNITY

The Inflatable Dam impounds approximately 5.1 km of river, creating essentially a long pool. Since pools are the preferred habitat of adult predatory fish (e.g., pikeminnow and smallmouth bass – see section 1.4 for detailed discussions of predator life histories), the habitat created behind the Inflatable Dam may result in an increase in the populations of these predators. Concentrating numbers of adult predators may lead to an increase in predation on salmonid smolts. This may be particularly true if smolts have difficulty migrating through the impoundment (see Manning *et al.* 2000, 2003). In addition, the pool formed behind the dam may create suitable habitat for spawning and rearing of predator fish. If conditions created by the impoundment are favorable, this may lead to an increase in survival of predatory fish that may disperse to other sections of the river.

Although the juvenile fish are susceptible to predation, river conditions early in the spring are not favorable for bass and pikeminnow predation. Periodic high turbidity events hinder prey detection and capture by predators that are sight feeders (bass and pikeminnow). In addition, bass tend to be relatively inactive at water temperatures below approximately 15°C. However, the dam is inflated as streamflow declines in the spring, generally around mid April. The reduction in streamflow and the impounding of the river leads to clearer water conditions, and potentially an increase in temperature.

Young-of-the-year (YOY) Chinook salmon are present in the Wohler study area from approximately late February through at least June. Chinook salmon average approximately 35 to 40 mm FL in length during the first few weeks of life, then quickly grow to approximately 80 mm FL by mid April. YOY-of-the-year steelhead are present from early to mid March throughout the remainder of the year. Young-of-the-year steelhead become relatively abundant in mid April, were they average approximately 40 mm FL. Steelhead smolts are present from at least early March through mid-June. Steelhead smolts are typically two years old at emigration, and range in length from approximately 150 to 239 mm FL (overall average in 2002 was 182 mm FL).

Some level of predation by the pikeminnow (native) and smallmouth bass (non-native) would likely occur with or without the dam. The question is, does the presence of the dam lead to increased predation over levels that would occur without the dam in place? Since it is not known what the predator populations would be in the Wohler Pool footprint without the dam in place, the focus of this study is to assess predator populations in the Wohler Pool under current conditions. This study examines both the overall number of each of the three potential predators, and the fraction of the population that is large enough to prey on the salmonids present in the river.

4.1 STUDY AREA

The study area was divided into four reaches. Reach #1 is located adjacent to Steelhead Beach Regional Park, and is located downstream of the Inflatable Dam. Reach 2 is located in the lower third of the Wohler Pool, Reach #3 is located in the middle third of the Wohler Pool, and the Reach 4 is located in the upper third of the Wohler Pool (Figure 4-1). The lower end of the Steelhead Beach reach is located approximately 2.5 kilometers downstream of the dam, and measures approximately 0.6 km in length. Reach #4 is at the upstream end of the Wohler Pool, and is minimally affected by the dam, with the influence of the dam declining to virtually zero at the upstream end. Habitat in the Reaches 2 and 3 is significantly altered by the Inflatable Dam. Access along the Russian River just above and below the Inflatable Dam (outside the influence of the Dam) is limited. A shallow riffle at the upstream end of Reach 4 was not passable in the electrofishing boat, and sites suitable for launching the electrofishing boat at other locations have not been identified at this point. These limitations prevented the expansion of the study into portions of the river that are not affected by the dam.

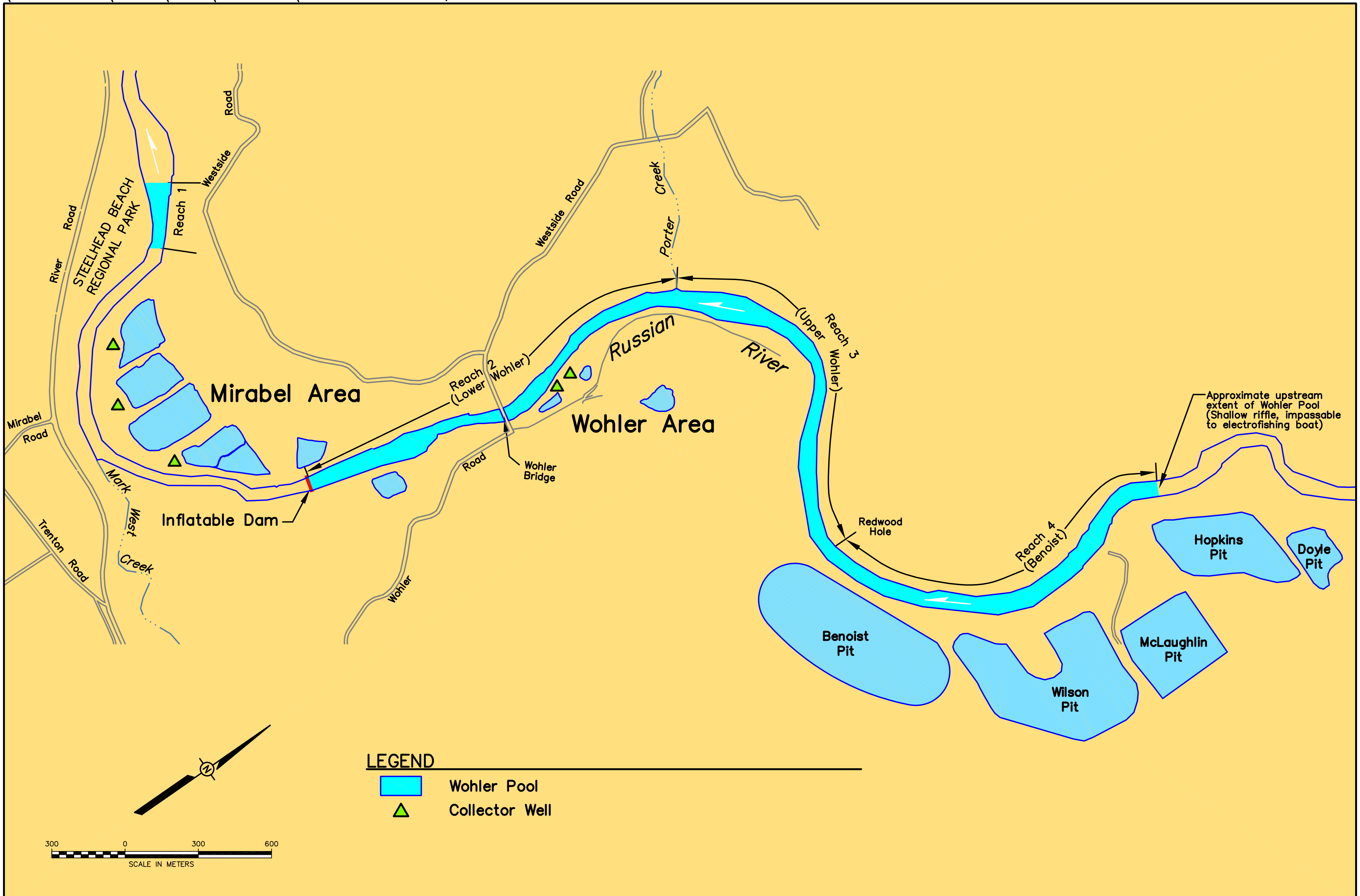

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Figure 4–1 Boat electrofishing reaches, August 2002

4.1 METHODS

4.2.1 Sampling Site Selection

Each Reach was divided into sampling stations of equal length, measuring 180 m. Depending on the length of the individual reaches, six or nine sampling stations were randomly selected. First, the river was divided into three sub units consisting of the left bank, the mid channel, and the right bank of the river. Starting at the downstream end of a Reach, a starting point within the river was randomly selected (i.e., either the left bank, mid channel, or right bank). Once an initial starting point was selected, a distance of 180 m was measured upstream, and constituted sampling station #1. At the upstream end of sampling station #1, one of the two remaining "sides" was randomly selected, and a distance of 180 m measured upstream. This constituted sampling station #2 for that Reach. The remaining side was selected as sampling station #3. At the upstream end of sampling station #3, the station order was repeated with sampling station #4 being the same side as sampling station #1. This strategy for selecting sampling locations was repeated for each Reach.

4.2.3 Boat Electrofishing

Fish were collected with a 16-foot electrofishing boat (Smith-Root, Inc. model SR16S). The electrofishing boat uses an onboard generator that sends an electric current through two anodes mounted to the front of the boat. A series of cathodes mounted on the front of the boat complete the current. The strength of the current is controlled by the boat operator, and is maintained at the minimum level required to effectively capture fish. The front of the boat is designed as a flat platform enclosed on the front and sides with safety railing. The platform is large enough to allow two crewmembers to net fish stunned during electrofishing. Fish are collected using nets that measure 17" X 17", mounted on eight-foot long fiberglass handles. The motor is mounted on a transom jack which allows the engine to be raised or lowered depending on water depth. The transom jack combined with the shallow draft of the boat allows for the safe operation in water less than two feet deep. A series of lights mounted on the front and rear of the boat allow for safe operation during nighttime sampling efforts. Electrofishing was conducted in early August to minimize the potential of encountering adult salmonids. Sampling was conducted during hours of darkness. Smallmouth bass have been shown to be more vulnerable to capture during electrofishing surveys conducted at night (Paragamian 1989). Sampling was conducted between 20:30 pm and 02:00 am. In addition, the potential to disrupt recreational user groups is greatly reduced. Electrofishing began at the downstream end of each sampling station, and proceeded upstream. Banks with cover (e.g., overhanging and aquatic vegetation) are sampled by maneuvering the boat such that the anodes are placed in the cover prior to the current being delivered to the water. This minimizes the potential of alerting fish to the presence of the current, and increases capture rates. Delivery of the current through the anode is controlled with a series of foot switches. One crewmember controlled the operation (on or off) of the electrofishing unit. In this way, the current was applied only when the anodes were in position to fish. A timer records the effort (i.e., number of seconds that the electrofishing unit was in operation) at each station. In addition, a second round of sampling was conducted at the three Reaches located above the dam. The second sampling effort focused solely on capturing large predatory fish, and included re-sampling portions of the river covered in the first round of sampling, as well as sampling habitat that provides habitat features favored by large piscivours.

During electrofishing, an attempt was made to net all fish stunned. However, special emphasis was placed on capturing target species (adult piscivorous fish) and juvenile salmonids. Fish captured were held in a live well. The live well was equipped with a recirculating pump and an aerator that supplied fresh, oxygenated water to the holding tank. Captured fish were identified to species and measured to the nearest 0.5 cm FL. Scale samples were collected from representative fish to determine the age structure of the fish community. Pikeminnow greater than 250 mm FL were tagged with a T-bar tag (Floytag Inc.). The location and length of each tagged fish was recorded. A second electrofishing survey was conducted the week following the original sampling event in an attempt to recapture as many tagged fish as possible. During the secondary (predator fishing) sampling event, only predators greater than 200 mm were targeted for capture. The ratio of tagged to untagged fish captured during the two surveys was used to estimate the number of smallmouth bass and pikeminnow exceeding 200 mm FL inhabiting the study area.

4.2 RESULTS

4.3.2 Boat Electrofishing

Boat electrofishing surveys have been conducted in August between 1999 and 2002. Four Reaches were sampled. Reach 1 was located downstream of the Inflatable Dam and consisted of four shoreline-sampling units and one mid-channel sampling unit. Reaches 2, 3 and 4 were located upstream of the Inflatable Dam and are contiguous. Reaches 2 and 4 consisted of nine sampling units each (six shoreline and three mid-channel units) and Reach 3 consisted of four shoreline-sampling units and two mid-channel sampling units. Water surface elevation (thus depth) is directly influenced by the dam in Reaches 2 and 3. Reach 4 is located above a relatively shallow glide (maximum depth 1.5 to 2.0 feet). The influence of the Inflatable Dam on depth is approximately 20 cm at the lower end of Reach 4, and zero at the upper end of Reach 4.

4.3.2.1 Community composition

During the 2002 sampling season, 2,356 fish representing 22 species and 9 families were collected (Table 4-1, Appendix G). In addition, juvenile Pacific lamprey were observed in most reaches in all years, but are too small to be captured with the dip nets used for this study. In 2002, nine of the 21 species captured were native to the Russian River, and native species comprised 69.2 percent of the catch. Overall, species composition in the study area was dominated by four species: Sacramento suckers (26.7 percent), smallmouth bass (25.3), hardhead (18.7 percent), and tule perch (16.4 percent) (Table 4-2).

In terms of relative abundance, species native to the Russian River account for five of the top six species in Reaches 2 through 4. Sacramento sucker, hardhead, tule perch, pikeminnow and California roach ranked 1, and 3 through 6 based on abundance in electrofishing surveys, respectively. Smallmouth bass were the second most abundant species captured during the surveys. Although Sacramento suckers were the most abundant species in Reach 1, the overall population was dominated by non-native fish. In terms of abundance, suckers were followed by smallmouth bass, Tule perch, green sunfish and bluegill. The major difference between Reach 1 and the three upstream reaches was the abundance of centrarchids (bass and sunfish). Even excluding smallmouth bass, non-native fish comprised 25.9 percent of the species composition in Reach 1. Non-native species (excluding smallmouth) ranged from 2.3 to 3.6 percent of the fish present in the three upstream reaches.

4.2.1 Catch-per-unit-effort

Catch-per-unit-effort (CPUE) is a measure of a species relative abundance. It is also a way of comparing sampling sites where the effort exerted to capture fish is not equal. The amount of effort spent at each site is dependent on several factors, including the size of the Reach, the number of fish present and the complexity of the habitat sampled. For this study, CPUE equals the average number of fish captured for every one-minute that the electrofishing unit was in operation at each site. Stations were separated into shoreline and mid-channel habitats, since species abundance and composition differ between the two.

The CPUE varied widely between individual shoreline sampling stations within and between the Reaches. Catch-per-unit-effort ranged from 0.77 fish/minute at Station 1-3 to 26.33 fish/minute at Station 4-9 (Table 4-3 and 4-4 presents CPUE data by Reach, Appendix G provides a breakdown of the CPUE by stations within each Reach). Catch-per-unit-effort above the dam ranged from 6.97 to 17.51 fish/minute. The CPUE at Reach #1 was intermediate to the above dam reaches (9.58 fish/minute). CPUE at the mid channel stations above the dam ranged from 2.09 to 3.23. The CPUE for the mid channel station in Reach 1 was higher than the CPUE in the mid channel Reaches above the dam.

Table 4-1. Total number of fish captured during boat electrofishing population sampling, Russian River, August 2002.

Species	Reach 1	Reach 2	Reach 3	Reach 4	TOTAL
Wild Steelhead	0	0	6	9	15
Hatchery Steelhead	0	1	0	0	1
Chinook	1	0	0	0	1
Pikeminnow	1	18	25	43	87
Hardhead	21	151	60	208	440
Roach	0	4	5	42	51
Hitch	0	0	0	0	0
Blackfish	15	1	0	0	16
Tule Perch	35	103	39	209	386
Sucker	167	96	124	243	630
Sculpin	0	0	1	3	4
Smallmouth bass	74	162	75	284	595
Largemouth bass	7	0	0	0	7
Bluegill	26	2	0	5	33
Green sunfish	30	0	1	13	44
Redear sunfish	2	0	0	0	2
Crappie	3	0	0	1	4
Shad	2	2	0	0	4
Carp	12	9	4	5	30
Bullhead	1	0	0	0	1
Channel Catfish	0	0	0	0	0
Stickleback	0	0	0	0	0
Striped bass	0	1	0	0	0
TOTALS	**398**	**550**	**341**	**1067**	**2356**

Table 4-2. Percentage composition of fish captured during boat electrofishing population sampling, Russian River, August 2002.

Species	Reach 1	Reach 2	Reach 3	Reach 4
Wild steelhead	0.0	0.0	1.8	0.8
Hatchery steelhead	0.0	0.2	0.0	0.0
Chinook salmon	0.3	0.0	0.0	0.0
Sucker	42.0	17.5	36.4	22.8
Tule Perch	8.8	18.7	11.4	19.6
Sculpin	0.0	0.0	0.3	0.3
Pikeminnow	0.3	3.3	7.3	4.0
Hardhead	5.3	27.5	17.6	19.5
Roach	0.0	0.7	1.5	3.9
Blackfish	3.8	0.2	0.0	0.0
Hitch	0.0	0.0	0.0	0.0
Carp	3.0	1.6	1.2	0.5
Smallmouth bass	18.6	29.5	22.0	26.6
Largemouth bass	1.8	0.0	0.0	0.0
Green sunfish	7.5	0.0	0.3	1.2
Bluegill	6.5	0.4	0.0	0.5
Redear sunfish	0.5	0.0	0.0	0.0
Crappie	0.8	0.0	0.0	0.1
Shad	0.5	0.4	0.0	0.0
White catfish	0.3	0.0	0.3	0.2
Bullhead	0.3	0.0	0.0	0.0
Striped bass	0.0	0.2	0.0	0.0
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**

Table 4-3. Catch-Per-Unit-Effort by Reach, Inflatable Dam Study Area, Russian River, August 2002.

Shoreline stations				
Species	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**
Wild Steelhead	0.00	0.00	0.13	0.17
Chinook	0.00	0.00	0.00	0.00
Pikeminnow	0.00	0.32	0.59	0.78
Hardhead	0.53	2.54	1.51	3.87
Roach	0.00	0.08	0.13	0.73
Blackfish	0.37	0.02	0.00	0.00
Hitch	0.00	0.00	0.00	0.00
Tule Perch	0.85	1.20	0.51	3.35
Sucker	3.78	0.72	2.32	2.93
Sculpin	0.00	0.00	0.03	0.04
Stickleback	0.00	0.00	0.00	0.00
Hatchery Steelhead	0.00	0.00	0.00	0.00
Smallmouth bass	1.83	2.60	1.66	5.21
Largemouth bass	0.19	0.00	0.00	0.00
Bluegill	0.69	0.04	0.00	0.09
Green sunfish	0.79	0.00	0.03	0.24
Redear sunfish	0.05	0.00	0.00	0.00
Crappie	0.08	0.00	0.00	0.00
Shad	0.05	0.02	0.00	0.00
Carp	0.32	0.17	0.08	0.06
Bullhead	0.03	0.00	0.00	0.00
White catfish	0.03	0.00	0.00	0.04
Striped bass	0.00	0.00	0.00	0.00
Totals	**9.58**	**7.71**	**6.97**	**17.51**

Table 4-4. Catch-Per-Unit-Effort by Reach, Mirabel Study Area, Russian River, August 2002.

Mid channel stations				
Species	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**
Wild Steelhead	0.00	0.00	0.03	0.00
Chinook	0.13	0.00	0.00	0.00
Pikeminnow	0.13	0.02	0.06	0.02
Hardhead	0.13	0.38	0.03	0.02
Roach	0.00	0.00	0.00	0.06
Blackfish	0.13	0.00	0.00	0.00
Hitch	0.00	0.00	0.00	0.00
Tule Perch	0.40	0.90	0.58	0.64
Sucker	3.17	1.30	1.02	1.84
Sculpin	0.00	0.00	0.00	0.02
Stickleback	0.00	0.00	0.00	0.00
Hatchery Steelhead	0.00	0.02	0.00	0.00
Smallmouth bass	0.66	0.56	0.31	0.11
Largemouth bass	0.00	0.00	0.00	0.00
Bluegill	0.00	0.00	0.00	0.00
Green sunfish	0.00	0.00	0.00	0.00
Redear sunfish	0.00	0.00	0.00	0.00
Crappie	0.00	0.00	0.00	0.02
Shad	0.00	0.02	0.00	0.00
Carp	0.00	0.00	0.03	0.04
Bullhead	0.00	0.00	0.00	0.00
White catfish	0.00	0.00	0.03	0.00
Striped bass	0.00	0.02	0.00	0.00
Totals	**4.76**	**3.23**	**2.09**	**2.79**

Determining the abundance of predatory fish is the key component of the Wohler Pool fish community surveys. Thus, in addition to the fish populations surveys conducted during this phase of the study, an additional sampling effort was conducted solely targeting large predatory fish. Data from both sampling efforts were combined to assess predator populations in the Wohler Pool. An additional, 151.5 minutes of sampling was exerted in Reaches 2 through 4 in an effort to more adequately assess the predator populations in the study area. The capture rate (CPUE) for Age 2+ and older (≥235 mm FL – fish large enough to prey on 80 mm FL by mid April) predatory fish was slightly higher in Reaches 2 and 3 (Wohler Pool stations), ranging from 0.19 and 0.15 fish/minute of sampling, compared to 0.11 fish/minute at Stations 1 and 4 (Table 4-5). The CPUE for Pikeminnow was highest in Reaches 2 and 4 (0.06 and 0.04 fish/minute, respectively). The CPUE for smallmouth bass was highest in Reaches 2 and 3 (0.13 fish/minute, respectively). Largemouth bass were only captured in Reach 1 (CPUE of 0.04 fish/minute). One striped bass was captured in Reach 2.

4.3.3 Salmonids

Sixteen wild and one hatchery steelhead were captured during the August 2002 sampling event. Wild steelhead were captured in Reaches 3 (7 total) and 4 (9 total) (Table 4-1). The hatchery steelhead was captured in Reach 2. Wild steelhead ranged in length from 110 to 310 mm FL (Figure 4-2). Appendix H presents length-frequency histograms for all species captured in each Reach).
Two Chinook smolts were captured in August 2002, marking the first time that this species has been captured during electrofishing surveys. One Chinook each was captured in Reaches one and two. The Chinook smolts measured 115 and 120 mm FL.

Table 4-5. CPUE of Age 2 and older predators, by Reach, 2002.

Species	Reach 1	Reach 2	Reach 3	Reach 4
Pikeminnow	0.02	0.06	0.02	0.04
Smallmouth bass	0.04	0.13	0.13	0.07
Largemouth bass	0.04	0.00	0.00	0.00
Total	**0.11**	**0.19**	**0.15**	**0.11**

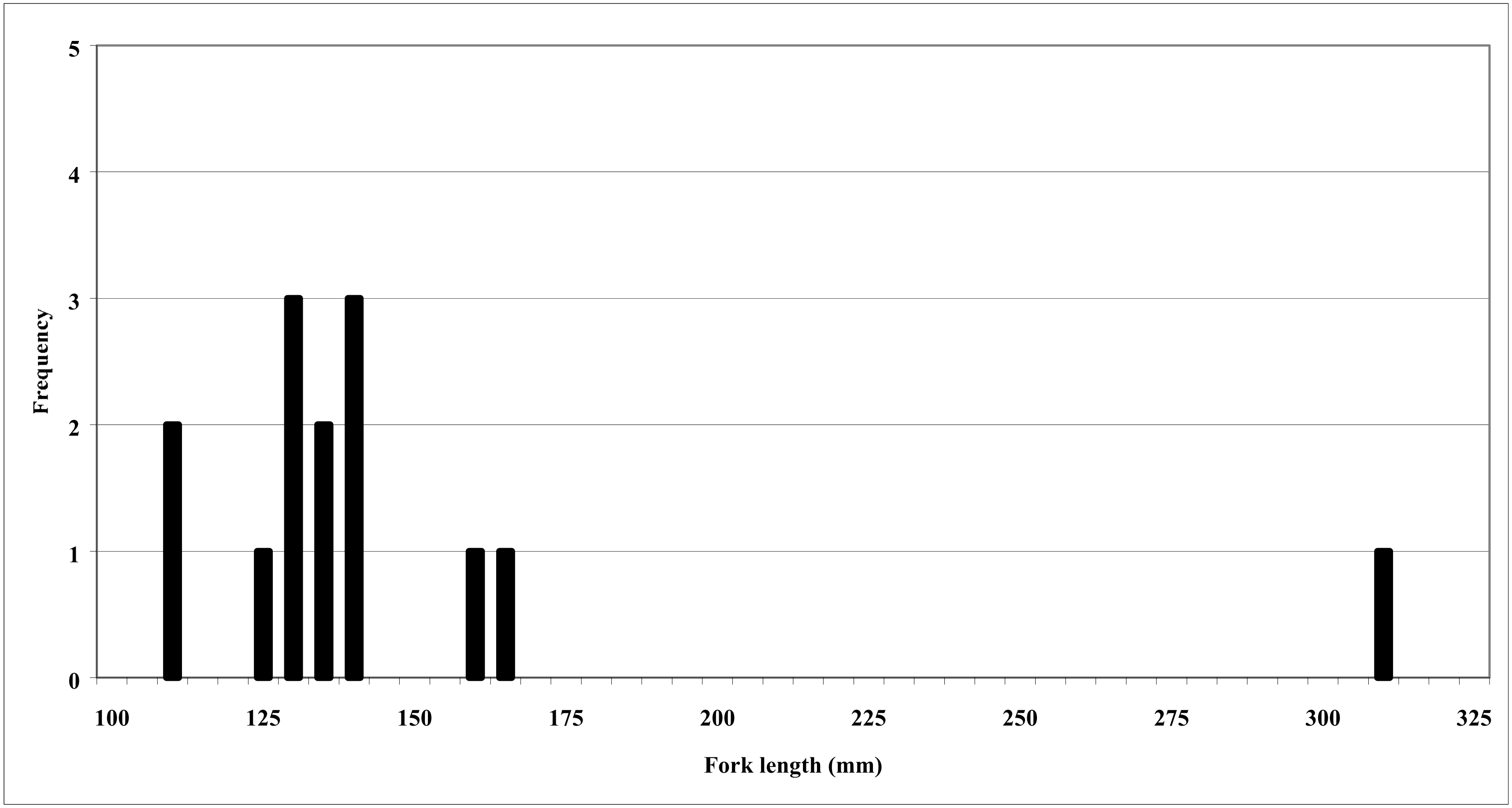

Figure 4-2. Length-frequency histogram for wild steelhead captured during boat electrofishing, August 2002 (all stations combined).

4.3.4 Adult Predator Populations

Four potential predators of salmonids were captured during the study: Sacramento pikeminnow, smallmouth bass, largemouth bass, and one striped bass (in addition, one juvenile striped bass was observed moving downstream through a fish ladder during video monitoring). In all, 29.3 percent (690) of all fish captured during electrofishing sampling fell in the predatory category. However, 80.7 percent (556) of the predators captured were young-of-the-year, and only 4.1 percent (28) of the predators were age 2+ or older (i.e., large enough to prey an 80 mm salmonid).

4.3.4.1 Pikeminnow

Pikeminnow comprised 3.7 (N=87) percent of the fish captured in 2002 (Tables 4-1 and 4-2) (excluding fish caught during the predator sampling event). Within individual reaches, pikeminnow comprised between 0.3 (Reach #1) and 7.3 (Reach #3) percent of the populations. Young-of-the-year accounted for 52 (59.8 percent) of the pikeminnow captured in 2002, while five (5.7 percent) were age as two-years-old or more (Figure 4-3).

In addition to the pikeminnow caught during the regular electrofishing sampling event, 15 additional pikeminnow greater than 200 mm FL were captured during the “predator” sampling event (20 total for the 2002 sampling season). All 20 pikeminnow were large enough to consume the largest Chinook captured during the emigration period, and 15 of the pikeminnow were large enough (≥425 mm FL) to eat an average size steelhead smolt

Although pikeminnow attain a large size, the abundance of pikeminnow greater than 200 mm FL appears to be low in the study area (Table 4-7). Combining all sampling events (1999 through 2002), the accumulative effort resulted in a relatively low number of pikeminnow captured in the study area. In total, 49 pikeminnow greater than 200 mm FL have been captured during four years of sampling (Table 4-6).

Table 4-6. Total number of pikeminnow and total number of pikeminnow greater than 200 mm FL captured by boat electrofishing, 1999 – 2002, combined.

Segment	Total number of pikeminnow	Total number of Pikeminnow greater than 200+	300+	400+	500+	Total
Reach 1[2,3,4]	13	1	2	0	0	3
Reach 2[1,3,4,5,6,7]	88	2	2	4	9	17
Reach 3[1,2,3,4,5,6,7]	83	5	2	0	5	12
Reach 4[1,2,3,4,5,6,7]	109	5	5	2	5	17

[1]Station sampled in August 1999.
[2]Station sampled in Spring 2000
[3]Station sampled in August 2000
[4]Station sampled during August 2001
[5]Station sampled during “predator” sampling event, August 2001
[6]Station sampled August 2002
[7]Station sampled during “predator” sampling event, August 2002

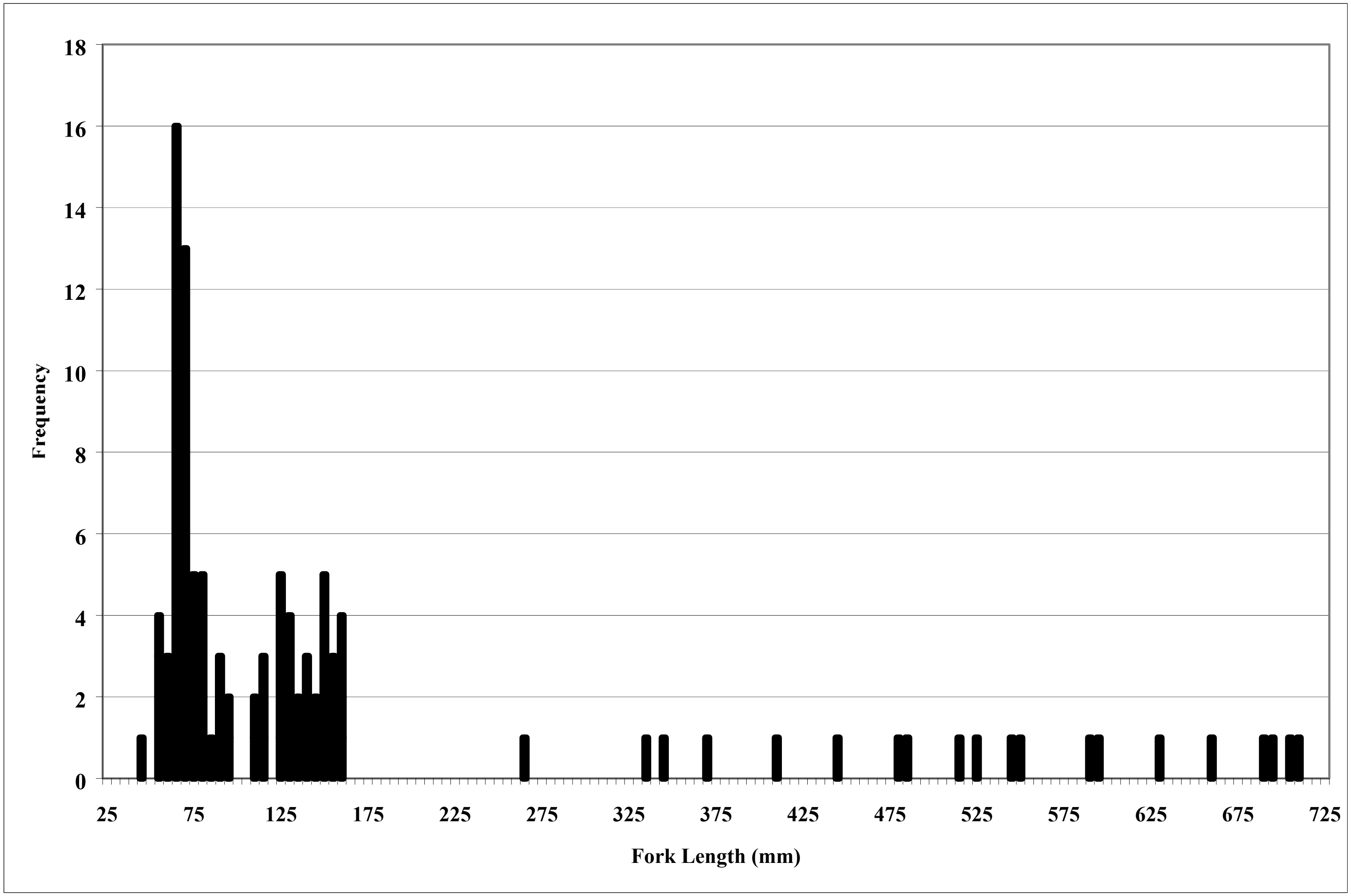

Figure 4-3. Length-frequency histogram of all Sacramento pikeminnow captured during boat electrofishing surveys, 1999 through 2002.

In 2002, pikeminnow ranged in size from 45 to 710 mm FL (Appendix G). Pikeminnow averaged 139 mm FL (N = 75, all sites and years combined) during August of their second year (age 1+), and 252 mm FL (N = 15) at age 2+ (Table 4-7). Based on the data collected to date, it appears that pikeminnow attain a size (>300 mm FL) to switch to a fish diet at the beginning of their fourth year of life (Age 3+) (Table 4-8). Pikeminnow aged as 4+ or older are large enough to prey on both Chinook salmon and steelhead.

Table 4-7. Average size and range by age class of Sacramento pikeminnow captured during boat electrofishing 1999-2002, Russian River.

Age Class	N =	Average fork length (mm)	Range
Age 0+	161	66	35 - 95
Age 1+	75	139	110 - 175
Age 2+	15	252	195 - 300
Age 3+	11	353	320 - 385
Age 4+	6	459	410 - 455
Age 5+	8	531	515 - 555
Age 6+ and older	10	660	590 - 710

4.3.4.2 Smallmouth bass

Smallmouth bass comprised 25.3 percent (595) of the total catch during the August 2002 sampling event. Within individual reaches, smallmouth bass comprised between 29.5 (Reach 2) and 18.6 (Reach 1) percent of the fish captured. Approximately 84 percent of the smallmouth bass captured were aged as young-of-the-year, and 21 fish (3.5 percent) were aged as two-years-old or more (Figure 4-4). Smallmouth bass were most abundant (based on CPUE) in Reach 4 (5.2 smallmouth bass/minute of sampling in shoreline sampling sites), followed by Reaches 2 (2.6 smallmouth bass/minute of sampling). Smallmouth bass were least abundant in Reach 1 (1.8 smallmouth bass/minute of sampling). It is noteworthy that Reach 1 is the smallest unit, consisting of one long pool).

Overall, very few adult smallmouth bass were captured during the study (48 total). Adult smallmouth bass (Age 2+ and older) were more abundant upstream of the dam (Table 4-9). At Reach 1, two adult smallmouth bass were captured, compared to 24, 12, and 10 in Reaches 2, 3, and 4, respectively (including the predator sampling event).

Smallmouth bass captured in August 2002 ranged in size from 45 to 405 mm FL (Figure 4-4). Smallmouth bass averaged 185 mm FL (N = 80, all site combined) during August of their second year (age 1+), and 272 mm FL (N = 43, all sites combined) at age 2+ (Table 4-9). No smallmouth bass large enough to prey on age 1+ or older steelhead were captured.

4.3.4.3 Largemouth bass

Largemouth bass comprised 0.3 percent (7) of the catch during the August 2002 sampling event, all in Reach 1. Two of the seven largemouth bass were aged as 0+, and two were aged as Age 2+ or older (Figure 4-5).

Largemouth bass captured in August 2002 ranged in length from 50 to 460 mm FL (Figure 4-5). Largemouth bass averaged 155 mm FL (N =, all sites combined) during August of their second year (age 1+), and 180 mm FL (N=2, all sites combined) during August of their third year (Age 2 +). Largemouth bass, based on their morphology, are able to feed on larger fish at a smaller size compared to smallmouth bass, thus, it is conservatively assumed that Age 2+ are large enough to feed on emigrating Chinook smolts during the start of their third year (Age 2+).

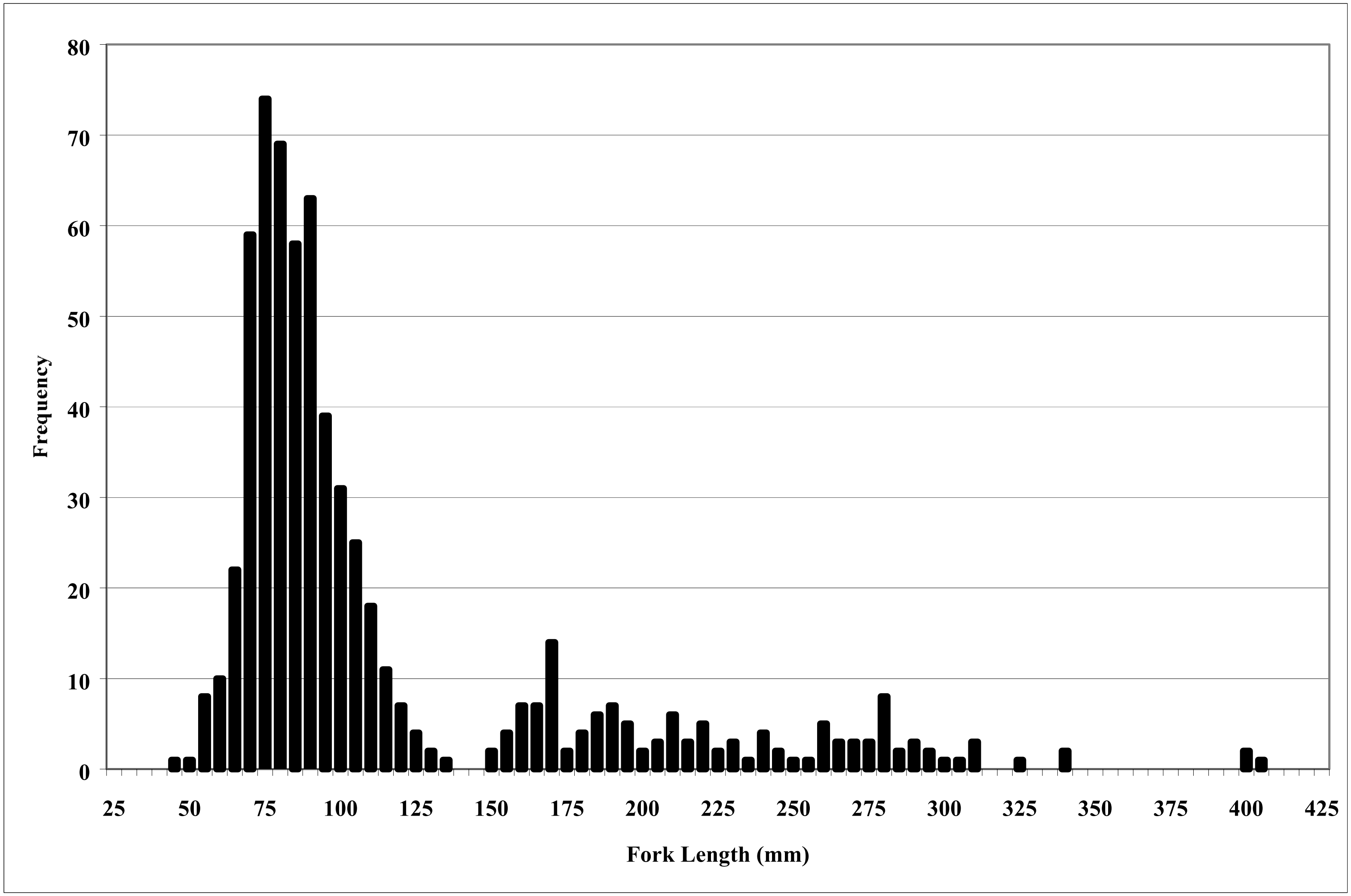

Figure 4-4. Length-frequency histogram for Smallmouth bass captured during boat electrofishing, August 2002.

Table 4-8. Average size and range by age class of smallmouth bass captured during boat electrofishing during August surveys, 1999 - 2002, Russian River (includes fish caught during the predator surveys).

Age 0+			
Segment	**Average**	**Range**	**N =**
1999	85	55 - 120	208
2000	79	50 – 120	1,067
2001	79	50 – 135	583
2002	85	45 - 135	503

Age 1+			
	Average	**Range**	N =
1999	180	150 - 210	20
2000	175	130 – 210	134
2001	181	140 – 230	151
2002	185	150 - 230	80

Age 2+			
	Average	**Range**	**N =**
1999	264	240 - 295	11
2000	252	220 - 280	17
2001	268	245 - 295	46
2002	272	235 - 310	43

Age 3+			
	Average	**Range**	**N =**
1999	325	310 - 350	6
2000	307	300 – 310	3
2001	362	325 – 380	6
2002	333	325 - 340	2

Age 4+			
	Average	**Range**	**N =**
1999	377	375 - 380	2
2000	370	370	1
2001	390	390	1
2002	402	400 – 405	3

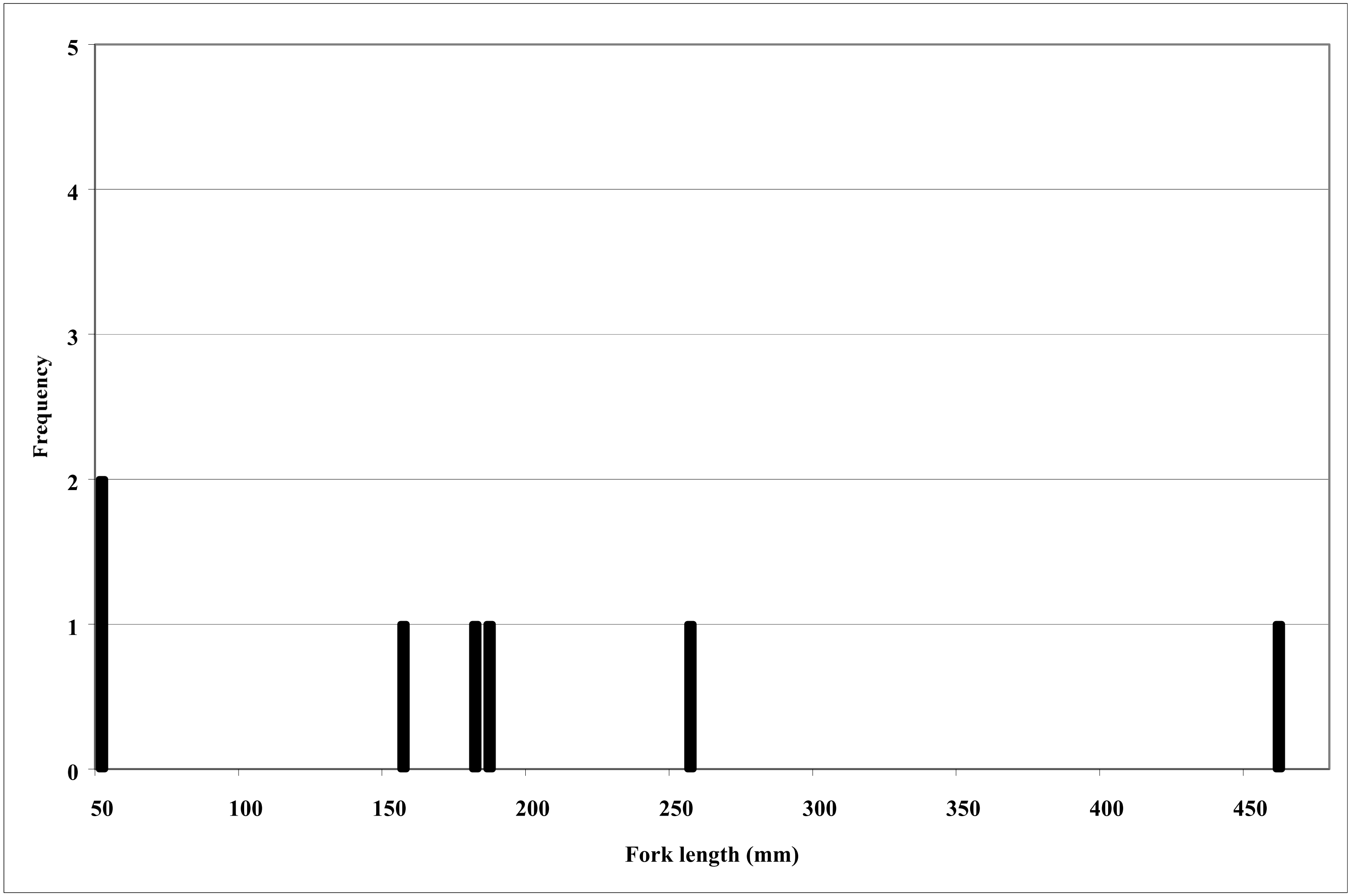

Figure 4-5. Length-frequency histogram for largemouth bass captured during boat electrofishing, August 2002.

Table 4-9. Average size and range by age class of largemouth bass captured during boat electrofishing, August 2000, Russian River.

Age 0+			
Segment	**Average**	**Range**	**N =**
1999			
2000	60	50 – 75	9
2001	56	40 – 65	9
2002	50	50	2

Age 1+			
	Average	**Range**	**N =**
1999	--	--	0
2000	122	110 – 125	6
2001	132	120-150	3
2002	155	155	1

Age 2+			
	Average	**Range**	**N =**
1999	--	--	0
2000	195	180 – 210	5
2001	195	175 – 220	4
2002	180	180 – 185	2

Age 3+			
	Average	**Range**	**N =**
1999	--	--	0
2000	253	250 – 255	2
2001	--	--	0
2002	255	255	1

Age 4+ and older			
	Average	**Range**	**N =**
1999	--	--	0
2000	430	430	1
2001	350	310 – 350	3
2002	460	460	1

4.3 SIGNIFICANT FINDINGS

During four years of sampling, four species of fish, smallmouth bass, Sacramento sucker, hardhead, and tule perch have dominated the fish community above the Inflatable Dam (Reaches 2, 3, and 4). The fish community in Reach 1 differed from the above dam Reaches by having a greater abundance of sunfish and tule perch, and a reduction in the abundance of smallmouth bass and hardhead. Wild and hatchery salmonids have been collected in relatively low numbers, primarily in Reaches 2 and 3 ("Wohler Pool").

Three potential salmonid predators inhabit the study area, Sacramento pikeminnow, smallmouth bass, and largemouth bass (in addition, a fourth species, striped bass, has also been captured in the Wohler pool, although only two individuals have been captured during four years of sampling). Pikeminnow were found in relatively low numbers. Although few adult pikeminnow were captured, they are capable of attaining a size large enough to feed on both Chinook salmon and steelhead smolts, and are a longed lived species (possibly up to 16 years (Moyle 2002). Smallmouth bass are the most abundant species inhabiting the study area. The majority of smallmouth bass captured were young-of-the-year, however. No smallmouth bass large enough to prey on steelhead smolts and very few smallmouth bass large enough to feed on an 80 mm FL Chinook smolts were captured. It is not known if the low number of older smallmouth bass is due a high rate of mortality among YOY bass, or a high rate of dispersal by YOY bass to areas outside of the study area. Winter habitat conditions (i.e., when the dam is deflated) may a least partially explain the poor recruitment of smallmouth bass to older age classes (see below). Very few largemouth bass were captured. Abundance of largemouth bass was highest in Reach #1 in all years sampled. All three predator species attain a size sufficient to prey on Chinook salmonids by the start of their third year of life (age 2+).

All four study Reaches provide suitable habitat conditions for the three predatory species of concern. Based on a review of habitat requirements for smallmouth and largemouth bass, Reach 1 and Reach 2 should provide the most suitable habitat in the study area when the dam is inflated. Stream gradient in the Russian River declines below the dam, and there are a higher frequency of pool type habitats compared to the above dam habitat (Chase et al. 2000). The greater depth and lower current velocity associated with pool habitats is preferred by Centrarchids (which include smallmouth and largemouth bass). Not surprisingly, centrarchids dominate the fish population in Reach 1.

Reach 2 has the deepest water (excluding the small hole at the upstream end of Reach #3), the lowest current velocities, and abundant cover. However, based on the electrofishing results presented below, smallmouth and largemouth bass abundances were lowest in the lower half of Reach #2 compared to the rest of the Study Reach. A potential explanation for this is the observed lack of habitat during the late winter/early spring period when streamflows are decreasing, but prior to dam inflation (streamflow between approximately 800 and 1,500 cfs). During high flow events, fish move into heavy cover to avoid high velocities. As flow drops after the cessation of winter rains, low velocity habitat (relatively deep water with heavy cover) is still available in Reaches 1, 3, and 4. Reach #1 is a main channel pool under normal summer base flows, and as high winter flows subside, habitat returns to this condition (thus low velocity refuge remains available to fish throughout the winter to summer transition period). Reach #4 is also primarily pool habitat that is only slightly influenced by the dam, and habitat response in a manner similar to Reach #1 as winter flows decrease. Habitat at Reach #3 without the dam would be classified primarily as a run/glide habitat, however. The thalweg (deepest section of the channel) remains against the right hand bank throughout most of the Reach. As streamflow decreases from winter to summer flows, moderate depths and cover (mainly overhanging vegetation and large woody debris) provide velocity relief for fish. Habitat in lower half of Reach #2, however, becomes a series of relatively shallow riffle and glide habitats with moderately high current velocities. The thalweg shifts to the middle of the channel through this section of the river, eliminating the potential benefits provide by overhanging vegetation and woody debris associated with the riparian corridor. Refuge from the relatively high velocity currents is lacking during the winter to summer transition period in the lower ¼ to ½ of the lower Wohler Pool. Although this theory is based on general observations made by a biologist, and not on empirical data, the electrofishing results supports this conclusion.

5.0 ADULT UPSTREAM MIGRATION

5.1 INTRODUCTION

The Inflatable Dam is approximately 11-feet high when fully inflated, and may form a barrier to upstream migrating fish. The dam is equipped with two denil-type fish ladders to provide for upstream passage, however, prior to this study, the effectiveness of the ladders had not been tested. The dam is typically inflated during at least the first half of the adult Chinook salmon migration period, and may remain inflated into the beginning of the adult steelhead migration period during years with low rainfall in the fall and early winter.

The main objective of this study was to verify that anadromous fish are able to ascend the fish ladders around the inflatable dam. A secondary objective assessed the timing of migration and relative numbers of anadromous fish utilizing the fish ladders while the dam was inflated.

5.2 METHODS

5.2.1 Time-Lapse Video Photography

Passage of adult salmonids through the fish ladders was assessed using underwater video cameras. The video system utilized at the fish ladders was designed specifically for this project. The system consists of two Sony™ ultra-high resolution monochrome video cameras with wide angle (105° lenses housed in waterproof cases. The images captured by the cameras were recorded on two Sony S-VHS time-lapse videocassette recorders. The taped images were viewed on a Sony ultra-high resolution dual input monochrome monitor. Lighting for each video camera was provided by two 36 LED high intensity red illuminators in waterproof housings that were mounted directly onto the camera housings.

A square metal extension (exit box), measuring 4'x4'x7', was mounted to the upstream end of the each fish ladder (Figure 5-1). The exit boxes conform to the sides of the fish ladders and are designed such that the hydraulics of the ladders was not altered. To facilitate fish identification, a highly reflective background was attached to the upstream wall of the exit boxes. The cameras were mounted in custom manufactured boxes extending off the downstream side of the exit boxes. The boxes were constructed of 3/16" steel. A clear acrylic window was inserted between the exit boxes and the camera boxes. Cameras were in operations almost continuously from mid-August until the dam was deflated in mid-December.

The recording speed (number of images recorded per second) for the time-lapse photography was held constant during the study. The time-lapse settings were set at one image recorded every 0.2 seconds, which equates to 24 hours coverage on a two-hour tape. Each time the tapes were changed, the camera lens' were cleaned with a soft rag, and the acrylic window and reflective background opposite the cameras were cleaned with a long handled squeegee.

Videotapes of the fish ladders were reviewed on high quality VCRs having a wide range of slow motion and freeze frame capabilities. When a fish was observed, tapes were reviewed frame by frame to determine the species and direction (upstream or downstream) of the fish. For each adult salmonid observed, the tape reviewer recorded the species (when possible), direction (upstream or downstream), date, and time of passage out of the ladder. During periods of low visibility, it was not always possible to identify fish to species, although identification to Family (e.g., Salmonidae) was often possible, and such fish were lumped into a general category called "salmonid." Fish identified as an adult Chinook salmon, steelhead, or salmonid were typically doubled checked by a senior biologist.

Figure 5-1. Photographs of video camera boxes and the upper end of the fish ladders around the Inflatable Dam.

5.3 RESULTS

Video monitoring demonstrated that adult salmon and steelhead were able to detect and ascend the fish ladders around the Inflatable Dam. Video monitoring provided conclusive evidence that salmonids plus a variety of other species were able to negotiate the ladders (Figure 3-1). The image quality of the videotapes was generally good to excellent, producing clear images suitable to accurately count the number of fish migrating through the fish ladders.

5.3.1 Video Monitoring

Video cameras were deployed on August 6, however, mechanical difficulties greatly limited sampling during the first half of August. The Westside video camera became effective on August 12, and the Eastside camera became effective on August 19. Overall, the system provided reasonably clear images of fish moving through the video cameras (Figure 4-2). Videotaping continued through the morning of December 11, 2002, when the dam was deflated. During this time-period, 232 videotapes were generated. Video monitoring was continuous throughout the study period with a few exceptions. On a few occasions, the end of a tape was reached prior to the tapes being changed, and the Eastside VCR failed between November 23 and November 28. In addition, turbidity occasionally limited visibility.

Video monitoring (1999 - 2002) demonstrated that adult Chinook salmon, steelhead, Pacific lamprey, and American shad, are able to locate and ascend the Mirabel fish passage facilities. The total number of adult anadromous fish passing through the fish ladder can only be estimated from the data collected, however, owing to a few problems inherent in the system. Turbidity was occasionally a problem, particularly during storm events, when turbidity levels increased to the point where the back wall of the exit boxes could not be observed, thus fish could have passed undetected. This is particularly troublesome because this limitation can only be minimally addressed by increasing the lighting in the exit boxes, and because salmon and steelhead tend to migrate during freshets which are associated with higher turbidity levels. However, the study objective was to determine if salmonids find and ascend the fish passage facilities, only. Data on the numbers of salmonids and the timing of upstream migration past the dam are a secondary objective. In addition, counts only represent numbers of fish migrating in the river during periods when the dam is inflated and the cameras were operated (August to mid December in 2002).

5.3.2 Fish Counts

At least twelve species of fish were identified entering the fish ladders in 2002. Species observed included Chinook and chum salmon, steelhead, Pacific lamprey, American shad, Sacramento pikeminnow, hardhead, Sacramento sucker, smallmouth bass, common carp, channel catfish, and striped bass (one juvenile was observed moving downstream through the ladders). Most of the non-anadromous species were noted as "milling about" in the exit boxes, as opposed to migrating upstream or downstream through the fish ladders. Detailed counts were made of anadromous fish, only. These counts were broken out by species, with a general category defined as salmonid (fish could not be identified to species, but had identifiable characteristics (e.g., general body shape, adipose fin, etc.) of the family Salmonidae.

5.3.2.1 Salmonids

In 2002, eight fish could be identified as a salmonid, but could not be identified to species. Salmonids were partitioned into Chinook or steelhead in an attempt to estimate the true number of each of these species observed in the fish ladders. Salmonids were partitioned by taking the percentage of Chinook salmon to steelhead identified in the ladder each day, and multiplying the number of salmonids by these percentages. In 2002, seven of the eight salmonids were classified as Chinook salmon, and the remaining fish was classified as a steelhead.

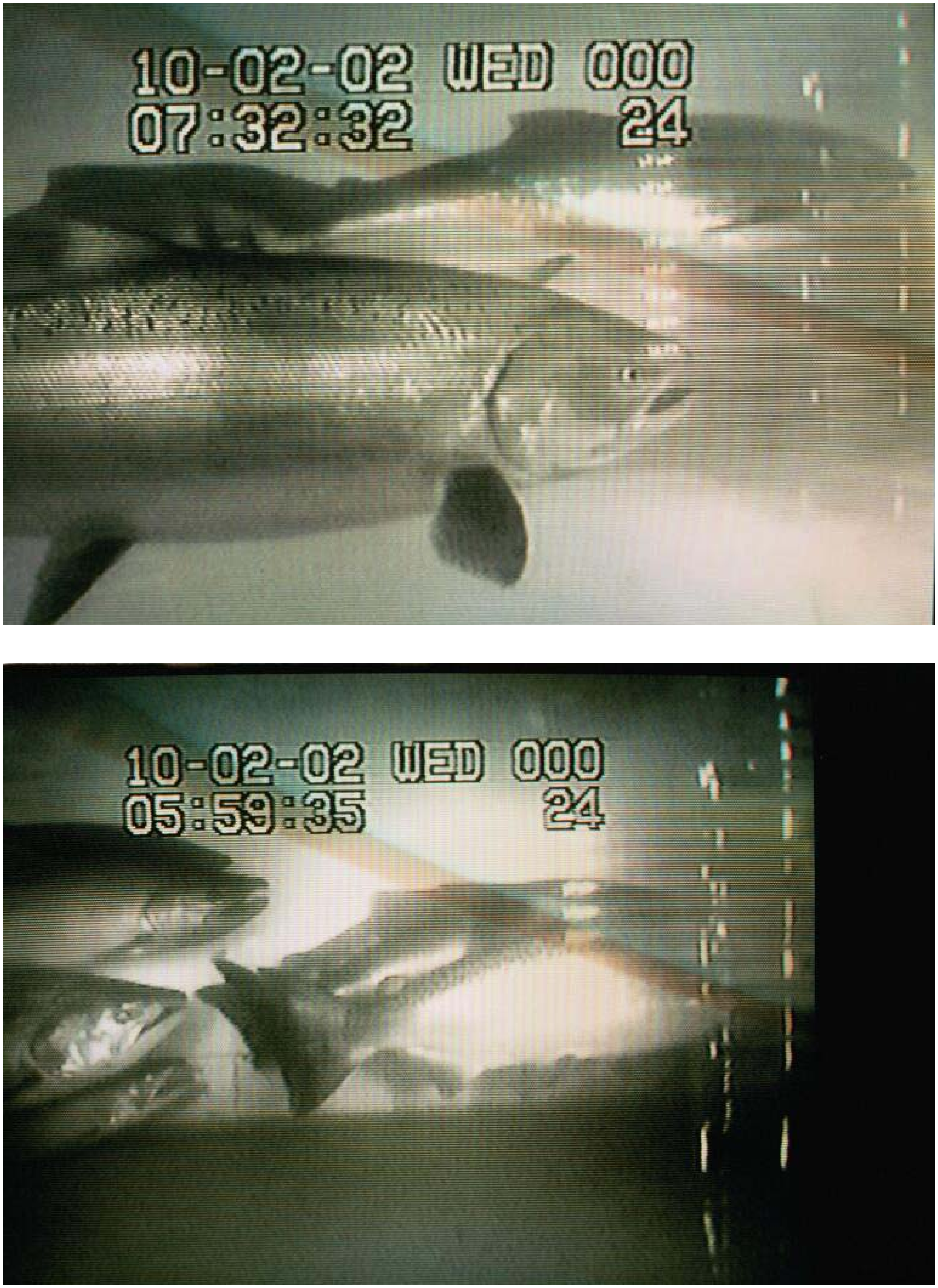

Figure 5-2. Video images of adult Chinook salmon passing through the exit box at the upper end of the west side fish ladder.

5.3.2.1 Chinook

The final Chinook salmon count for 2002 was 5,466 (5,474 including "salmonids"). However, owing to a few technical difficulties, as well as poor water quality on a few days, this number is likely an underestimate of the true run size for this year for the following reasons:

- On 3 occasions, the end of the videotapes was reached prior to being changed for the day. On two of the days, few salmonids were observed migrating past the cameras during the day. It is likely that few, if any fish were missed on these days. However, the tapes ran out for 2 hours and 50 minutes on October 2, during the second largest daily total recorded during four years of video surveys. 122 Chinook salmon migrated past the cameras during the last hour prior to the tapes running out, and 20 Chinook migrated past the cameras after the tapes were changed. It is likely that somewhere between 60 and 360 Chinook were missed prior to the tapes being changed.

- On two occasions (October 2 and November 7), the sheer number of fish passing in front of the camera prevented an accurate count. Up to 10 fish were observed in front of the cameras at one time. Some of the fish milled about in front of the cameras for an extended period-of-time, sometimes dropping below the cameras view, then moving back into view. At other times, a fish would move close to the camera, blocking the view of the other fish. The combined effect made accurately counting the fish passing through the ladder difficult.

- On the morning of November 7, through November 8, visibility decreased to virtually zero. The count on November 7 was the single largest daily count recorded during four years of video monitoring. Prior to visibility declining to near zero, over 2,000 Chinook salmon were observed migrating past the cameras. An unknowable, but likely substantial, number of fish migrated past the dam uncounted due to the lack of visibility.

- The Eastside camera was out of service for 7 days (6 days because the VCR malfunctioned, and one day because the lights malfunctioned) during the 2002 sampling season. During these 7 days, 38 Chinook salmon were counted migrating past the Westside camera (the percentage of fish passing each camera was approximately 50-50).

- Chinook salmon were still being recorded in low, but consistent numbers when the dam was deflated (average of approximately 3 fish per day over the final 2 weeks of video monitoring, excluding December 10, when 29 Chinook were counted).

Chinook salmon were first observed during video monitoring on August 20, although only 9 Chinook salmon were observed prior to September 1. The majority of the Chinook salmon observed occurred during three pulses, the first occurring between October 1 and 2 (21.1 percent of the run); between October 15 and 16 (9.8 percent of the run), and November 6 and 7 (45.6 percent of the run) (Figure5-2). Adult Chinook salmon were captured through the end of the sampling season (when the dam was deflated on December 11). Based on the four years of (mainly partial) data, the Chinook salmon run in the Russian River begins in earnest mid September, peaks mid October through mid November, and ends in late December.

The large run of fish recorded between October 1 and 2 (primarily on the 2nd) coincided with the removal of two seasonal dams on the lower river. On October 1, the Johnson Beach and Vacation Beach dams were removed. These dams are located downstream of the Mirabel dam. Starting at approximately 04:40 on the morning of October 2, the first fish reached and began ascending the fish ladders at the Inflatable Dam. The run continued at a high level through approximately midnight on October 2. Interestingly, the mouth of the estuary had been closed for the 5 days prior to the lowering of the seasonal dams. Thus, the fish had been holding in the lower river for at least this length of time prior to the dams being removed (both of the lower river dams have fish ladders to assist migrating fish). Prior to October 1, 185 Chinook salmon had been counted at the Inflatable Dam; thus, the fish ladders on the lower dams are at least partially effective.

Table 5-1. **Weekly counts of Chinook salmon (includes "salmonids") observed migrating upstream through the Inflatable Dam fish passage facilities during video monitoring, 1999-2002 sampling seasons.**

Date	1999	2000	2001	2002
1-Aug	0	0	0	0
8-Aug	0	0	0	0
15-Aug	1	0	0	1
22-Aug	0	1	0	8
29-Aug	1	0	3	7
5-Sep	3	9	1	18
12-Sep	0	38	7	19
19-Sep	11	23	12	65
26-Sep	0	50	17	1,223
3-Oct	30	31	240	113
10-Oct	7	115	51	628
17-Oct	164	81	10	272
24-Oct	20	466	300	153
31-Oct	56	63	661	505
7-Nov	3	24	81	2,337
14-Nov	--	182	--	20
21 Nov	--	200	--	37
28 Nov	--	111	--	14
5-Dec	--	19	--	54
12-Dec	--	14	--	--
19-Dec	--	17	--	--
26-Dec	--	1	--	--
2-Jan	--	0	--	--
9-Jan	--	0	--	--
Totals	**296**	**1,445**	**1,383**	**5,474**

[1]Dam deflated on November 14 (weekly totals include 96 "salmonids")
[2]Dam deflated on January 10, 2001 (weekly totals include 188 "salmonids")
[3]Dam deflated on November 13 (weekly totals include 84 "salmonids")
[4]Dam was deflated on December 11, 2002 (weekly totals include 10 "salmonids")

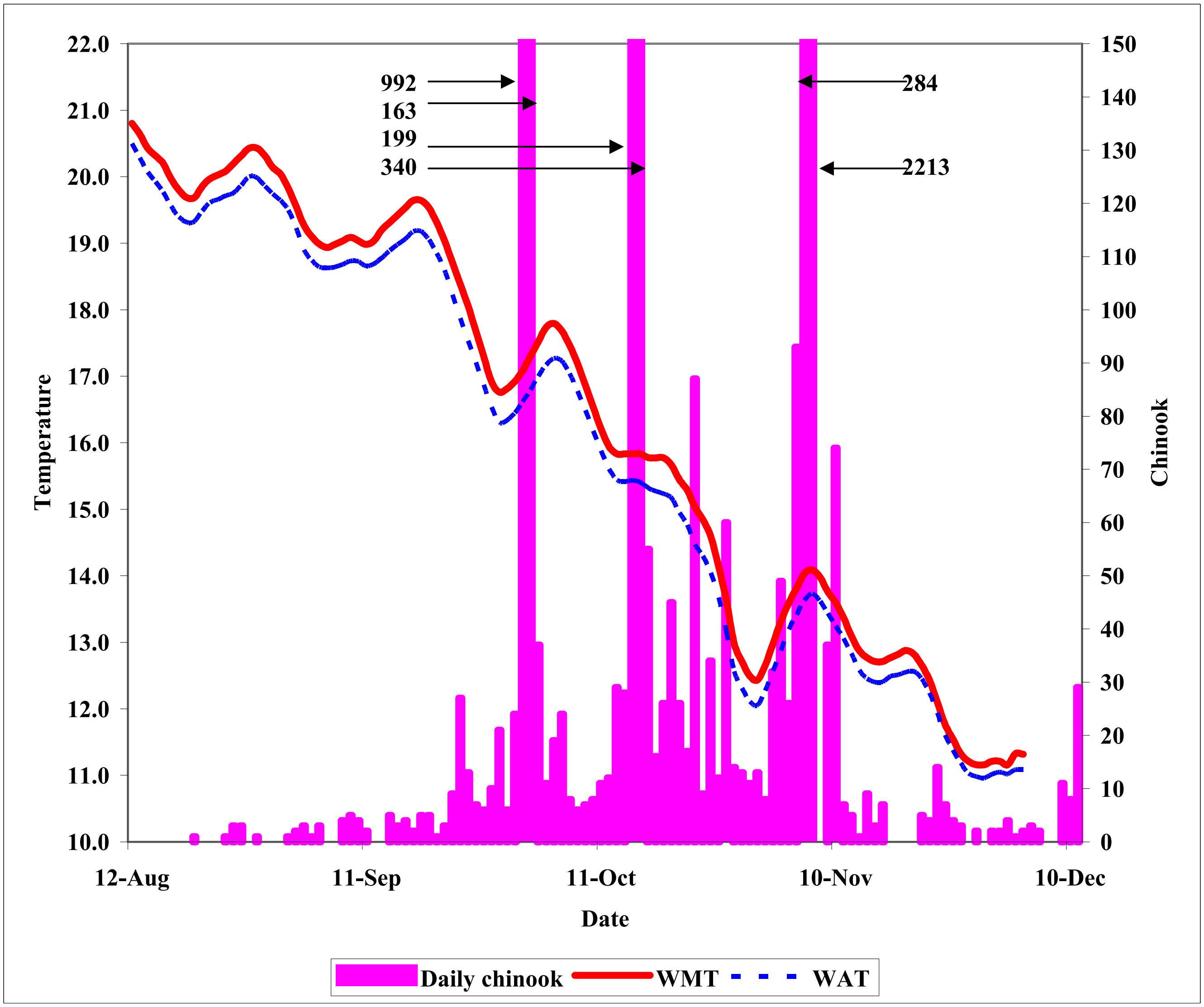

Figure 5-3. **Daily Chinook salmon counts plotted against the weekly average temperature (WAT) and the weekly maximum temperature (WMT) recorded in the Russian River, August 12 through December 11, 2002 (the right axis truncated to highlight daily catches in between peak counts. Numbers with arrows provide the daily catch for truncated dates).**

Average daily water temperatures ranged from 20.7 to 10.2°C during the 2002 upstream migration period (Figure 5-3). The weekly average temperature during late August and September ranged from 18.9 to 20.0°C. Beginning October 1, the weekly average temperature was 16.6°C, and generally declined as the run progressed. The weekly average water temperature ranged between approximately 16.5°C and 13.5°C during the three peak days of the Chinook migration period (October 2, October 16, and November 7).

5.3.2.3 Steelhead

In 2002, 101 adult steelhead (39 wild, 52 hatchery, and 10 of unknown origin) were counted during video monitoring. Adult steelhead have been observed in large numbers only in 2000 (when the video monitoring continued into January. Adult steelhead apparently begin migrating through the Russian River in late November, with peak months likely being December through March.

5.3.2.4 Juvenile steelhead

Wild, hatchery, and smolts of undetermined origin are observed annually passing through the fish ladder throughout the sampling season. In addition, several steelhead smolts were observed entering the exit boxes "milling about" and leaving the box in the same direction from which it originally entered. Since it was possible that at least some of the observations were the same fish passing upstream and downstream repeatedly through the boxes, it was not possible to estimate the number of fish moving past the dam during the year. The data does indicate that at least a few juvenile steelhead inhabit the Russian River in the vicinity of the Mirabel Dam throughout the summer.

5.3.2.5 Pacific lamprey

In California, Pacific lamprey migrate upstream and spawn during the winter and spring (January through March (Trihey and Associates 1996, Chase 2001), March through late June (Moyle 2002), and the fall in the Trinity River, Moffett and Smith (1950, cited by Moyle 2002) and the Napa River (Wang 1986). Moyle (2002) concluded that there might be at least two distinct runs of Pacific lamprey in some rivers (similar to the multiple spawning runs of Chinook salmon observed in larger rivers). Pacific lamprey were observed sporadically between October 1 and December 10 in 2002 (Table 5-2). In 2000, video surveillance continued from May 12 through January 10, 2001. 228 Pacific lamprey were observed in the fish ladders, primarily in May and June, with small numbers of Pacific lamprey observed migrating upstream through the fish ladders in late October and November (one was also observed in early January). Although the possibility exists for two distinct runs of lamprey in the Russian River based on the data collected (a fall run and a spring run), the data are inconclusive because of the lack of sampling during the late fall/winter period when the dam is deflated. The numbers of lamprey reported here are likely underestimates. Pacific lamprey can be difficult to observe on the videotapes, particularly during periods of low visibility (high turbidity).

Table 5-2. Daily counts of adult Pacific lamprey observed migrating through the fish ladders at Mirabel during video monitoring, Russian River, 1999-2002.

Date	1999	2000	2001	2002
9-May	0	3		N/S
16-May	0	44	N/S	N/S
23-May	4	17	N/S	N/S
30-May	0	23	N/S	N/S
6-June	0	34	N/S	N/S
13-June	0	69	N/S	N/S
20-June	0	3	N/S	N/S
27-June	0	0	N/S	N/S
4-July	0	1	N/S	N/S
11-July	0	0	N/S	N/S
18-July	0	0	N/S	N/S
25-July	0	0	N/S	N/S
1-Aug	0	0	0	0
8-Aug	0	0	0	0
15-Aug	0	0	0	0
22-Aug	0	0	0	0
29-Aug	0	0	0	0
5-Sep	0	0	0	0
12-Sep	0	0	0	0
19-Sep	0	0	0	0
26-Sep	0	0	0	1
3-Oct	0	0	0	2
10-Oct	1	0	0	1
17-Oct	0	0	0	0
24-Oct	23	17	0	1
31-Oct	13	11	1	0
7-Nov	9	0	2	1
14-Nov	0	0	0	0
21 Nov	N/S[1]	3	0	0
28 Nov	N/S	2	N/S	0
5-Dec	N/S	0	N/S	13
12-Dec	N/S	0	N/S	N/S
19-Dec	N/S	0	N/S	N/S
26-Dec	N/S	0	N/S	N/S
2-Jan	N/S	1	N/S	N/S
9-Jan	N/S	0	N/S	N/S
Totals	**50**	**228**	**3**	**19**

N/S[1] = Not Surveyed

5.4 SIGNIFICANT FINDINGS

Based on the results of video monitoring from 1999 through 2002, Chinook salmon and steelhead appear to be highly successful in finding and ascending the fish ladders around the Inflatable Dam. Relatively large numbers of adult fish of both species have been documented negotiating the ladders, and large numbers of fish milling at the base of the dam have not been observed. However, a satisfactory method of assessing fish holding at the base of the dam has not been identified. Direct observation (snorkel) surveys were limited by visibility, which tends to deteriorate in November when Chinook salmon and steelhead are most likely to be present in large numbers.

In 2002, approximately 5,500 adult Chinook salmon were counted ascending the fish ladders at the Mirabel Dam. The 2002 run represents an approximate 3.5 times increase over the number of Chinook salmon counted passing the dam in 2000, when virtually the entire run was surveyed. This is in contrast to historical literature that suggests that Chinook salmon were never abundant in the Russian. Steiner (1996) reviewed the historical literature pertaining to salmonids in the Russian River and cited several sources that suggested that Chinook salmon were rare in the Russian River. For example, Shapovalov (1946, 1947, and 1955) reported that there were few, if any, Chinook salmon in the Russian River. Although a few sources did suggest that Chinook salmon inhabit the Russian, Steiner concluded that: "… there are very few chinook presently in the Russian River basin." Moyle (2002), states that Chinook salmon in the Russian River "disappeared" from the river due to the advent of agriculture and water projects in the river, and that attempts to reestablish Chinook salmon through stocking have not appeared to be successful. In 2001, approximately 1,380 adult Chinook salmon were observed migrating upstream through the fish ladders. The Chinook run essentially began in early September during the four years sampled (1999-2002). The entire spawning run has been surveyed in its entirety in 2000, only (Chase *et al*. 2001). In 2000, the run peaked in late November and ended in late December. During August of each of the first three years sampled, one Chinook salmon has been observed in the fish ladders, and nine were counted in 2002. Relatively large numbers of salmon have not been observed prior to October in any year.

In 2002, 76.5 percent of the fish were counted over six days: October 1 and 2, (21.1 percent, primarily on the 2nd), October 15 and 16 (9.9 percent), and November 16 and 17 (45.6 percent). The 2,213 Chinook salmon counted on November 17 was greater than any annual total count from the previous three years sampling.

Based on the paucity of historical records of Chinook salmon inhabiting the Russian River, the genetic origin of the Chinook salmon in the Russian River has been debated. There are at least three hypotheses to explain the presence of Chinook in the basin. First, they are remnants of a native run that was largely unnoticed during the past 100 years (possibly existing at very low population levels). Secondly, they may have resulted from the extensive stocking programs carried out over the last 100+ years. Finally, they may be strays from the Eel and/or the Sacramento rivers. Preliminary data from a genetics study conducted by the Bodega Bay Marine Lab (BBML 2002) concluded that the Russian River Chinook population is not closely related to Eel River or Central Valley (Sacramento-San Joaquin rivers) populations. Further, BBML (2002) states that "Chinook in the Russian River do appear to belong to a diverse set of coastal Chinook populations." Based on the results of the BBML, the leading hypothesis for the origin of the Russian River Chinook salmon is that they are a native run that has been largely unnoticed. The reason why these fish showed up in relatively large numbers in 2002 is unknown.

Adult steelhead began their upstream migration in late October, however, the majority of their run occurs after the dam is deflated. Thus, little run information is available for this species.

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APPENDIX A

COMMON WATER TEMPERATURES FOUND IN THE STUDY AREA IN CELSIUS AND FAHRENHEIT

Appendix A. Common water temperatures found in the study area in ºCelsius and ºFahrenheit.

ºC[1]	ºF
5.0	41.0
6.0	42.8
7.0	44.6
8.0	46.4
9.0	48.2
10.0	50.0
11.0	51.8
12.0	53.6
13.0	55.4
14.0	57.2
15.0	59.0
16.0	60.8
17.0	62.6
18.0	64.4
19.0	66.2
20.0	68.0
21.0	69.8
22.0	71.6
23.0	73.4
24.0	75.2
25.0	77.0
26.0	78.8
27.0	80.6
28.0	82.4
29.0	84.2
30.0	86.0

[1]The formula to convert ºC to ºF is:
(ºC X 1.8) + 32

APPENDIX B

DAILY MAXIMUM, AVERAGE, AND MINIMUM WATER TEMPERATURES RECORDED NEAR THE RIVER'S SURFACE AND THE DEEPEST POINT AT EACH SAMPLING STATION WITHIN THE MIRABEL STUDY AREA, 2002 SAMPLING SEASON

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #1 at a depth 2.0 meters, April 6 through June 27, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
6-Apr	16.4	14.6	12.9		20-May	16.0	15.3	14.9
7-Apr	16.8	15.3	14.1		21-May	17.5	15.7	14.1
8-Apr	15.6	14.8	14.1		22-May	19.0	16.7	14.5
9-Apr	14.5	14.1	14.1		23-May	20.2	17.9	15.2
10-Apr	17.1	15.2	13.3		24-May	21.3	18.9	16.4
11-Apr	17.1	16.1	15.2		25-May	21.3	19.3	17.1
12-Apr	18.3	16.5	14.9		26-May	21.3	19.4	17.5
13-Apr	19.4	17.5	15.6		27-May	20.6	19.0	17.5
14-Apr	20.2	18.3	16.8		28-May	21.7	19.5	17.5
15-Apr	17.1	15.5	14.1		29-May	23.6	21.0	18.7
16-Apr	14.9	13.9	13.3		30-May	24.4	22.0	19.8
17-Apr	15.6	13.7	12.2		31-May	23.6	21.7	19.8
18-Apr	15.6	14.1	12.6		1-Jun	22.9	21.0	19.0
19-Apr	16.8	14.6	12.6		2-Jun	22.1	20.3	18.3
20-Apr	17.5	15.5	13.7		3-Jun	22.5	20.2	18.3
21-Apr	18.3	16.3	14.5		4-Jun	23.2	20.7	18.3
22-Apr	19.0	16.9	14.9		5-Jun	24.4	21.9	19.4
23-Apr	19.4	17.4	15.2		6-Jun	24.0	21.8	19.4
24-Apr	18.7	17.3	16.4		7-Jun	22.5	20.4	18.3
25-Apr	19.0	17.0	14.9		8-Jun	21.3	19.2	17.5
26-Apr	19.0	17.3	16.0		9-Jun	20.6	18.6	16.0
27-Apr	17.1	16.0	14.9		10-Jun	22.1	20.0	17.5
28-Apr	16.0	14.9	13.3		11-Jun	22.5	20.7	18.7
29-Apr	15.6	14.8	14.1		12-Jun	21.3	19.9	18.3
30-Apr	14.5	14.0	13.3		13-Jun	21.0	19.2	17.5
1-May	16.8	14.8	12.9		14-Jun	21.7	19.7	17.5
2-May	18.3	15.9	14.1		15-Jun	22.1	19.9	17.9
3-May	18.3	16.6	15.2		16-Jun	22.5	20.1	17.9
4-May	19.0	16.9	14.9		17-Jun	22.5	20.4	18.3
5-May	19.8	17.6	15.6		18-Jun	23.6	21.3	19.0
6-May	19.8	17.6	15.6		19-Jun	24.0	21.6	19.4
7-May	19.0	17.2	15.2		20-Jun	23.2	21.3	19.4
8-May	19.4	17.3	15.2		21-Jun	22.5	20.7	19.0
9-May	19.4	17.3	15.2		22-Jun	22.5	20.5	18.7
10-May	18.7	16.7	14.5		23-Jun	22.9	20.7	18.3
11-May	19.8	17.4	14.9		24-Jun	23.2	21.0	18.7
12-May	19.8	17.8	15.6		25-Jun	23.2	21.2	19.0
13-May	20.2	18.0	16.0		26-Jun	21.7	20.5	18.7
14-May	20.6	18.1	15.6		27-Jun	21.0	20.0	19.4
15-May	21.0	18.7	16.4					
16-May	21.0	18.8	16.4					
17-May	21.3	18.9	16.4					
18-May	20.2	18.5	16.8					
19-May	17.9	16.9	16.0					

Appendix B. Daily maximum, average, and minimum water temperatures recorded at Station #2 at a depth 0.5 meters, June 1 through October 10, 2002.

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
1-Jun	22.5	20.9	19.0		15-Jul	23.2	21.0	19.4
2-Jun	22.1	20.2	18.7		16-Jul	22.5	20.3	19.0
3-Jun	22.1	20.0	18.3		17-Jul	22.5	20.3	18.7
4-Jun	23.2	20.6	18.3		18-Jul	22.9	20.5	18.7
5-Jun	24.4	21.9	19.8		19-Jul	23.6	21.0	19.0
6-Jun	24.0	21.9	20.2		20-Jul	24.0	21.6	19.8
7-Jun	22.5	20.7	19.0		21-Jul	21.7	20.5	19.8
8-Jun	21.0	19.5	17.9		22-Jul	22.1	19.7	18.3
9-Jun	20.6	18.6	16.8		23-Jul	22.5	20.1	18.3
10-Jun	22.1	19.8	17.9		24-Jul	22.9	20.3	18.3
11-Jun	22.5	20.6	19.0		25-Jul	22.5	20.1	18.7
12-Jun	21.3	19.8	18.3		26-Jul	22.9	20.5	18.7
13-Jun	20.6	19.1	17.5		27-Jul	23.2	20.7	19.0
14-Jun	21.7	19.5	17.9		28-Jul	21.7	20.1	19.0
15-Jun	22.1	19.7	17.9		29-Jul	22.1	20.1	18.7
16-Jun	22.5	20.0	17.9		30-Jul	22.5	20.4	19.0
17-Jun	22.5	20.4	18.3		31-Jul	22.5	20.4	19.0
18-Jun	23.6	21.3	19.4		1-Aug	22.9	20.5	19.0
19-Jun	23.6	21.5	19.4		2-Aug	22.5	20.4	19.0
20-Jun	23.2	21.3	19.4		3-Aug	20.6	19.2	18.7
21-Jun	22.5	20.7	19.0		4-Aug	21.0	18.7	17.1
22-Jun	22.5	20.5	18.7		5-Aug	21.7	19.2	17.1
23-Jun	22.9	20.6	18.7		6-Aug	21.7	19.2	17.1
24-Jun	23.2	20.9	19.0		7-Aug	22.1	19.6	17.5
25-Jun	23.2	21.1	19.4		8-Aug	22.9	20.8	17.9
26-Jun	22.1	20.7	19.4		9-Aug	23.2	20.7	18.7
27-Jun	22.9	21.1	19.4		10-Aug	23.2	20.9	19.0
28-Jun	24.0	21.5	19.8		11-Aug	22.5	20.4	18.7
29-Jun	24.8	22.1	20.2		12-Aug	22.5	20.1	18.3
30-Jun	25.6	22.8	21.0		13-Aug	22.1	20.0	18.7
1-Jul	25.6	23.0	21.0		14-Aug	22.1	19.9	18.3
2-Jul	24.4	22.6	21.3		15-Aug	21.7	19.8	18.7
3-Jul	23.6	21.7	20.2		16-Aug	21.3	19.4	18.3
4-Jul	24.0	21.6	19.8		17-Aug	21.3	19.2	17.9
5-Jul	24.0	21.5	19.4		18-Aug	21.0	19.1	17.9
6-Jul	24.4	21.7	19.8		19-Aug	20.6	18.9	17.9
7-Jul	24.4	22.0	20.2		20-Aug	21.3	19.0	17.5
8-Jul	24.8	22.0	19.8		21-Aug	21.3	19.2	17.5
9-Jul	25.6	22.7	20.6		22-Aug	20.2	19.6	18.7
10-Jul	26.3	23.3	21.0		23-Aug	20.2	18.2	17.1
11-Jul	25.2	22.9	21.0		24-Aug	20.2	18.4	17.1
12-Jul	24.4	22.4	21.0		25-Aug	21.0	18.8	17.1
13-Jul	24.0	21.8	20.2		26-Aug	21.7	19.2	17.1
14-Jul	23.6	21.5	19.8		27-Aug	22.1	19.9	18.3

Appendix B. Daily maximum, average, and minimum water temperatures recorded at Station #2 at a depth 0.5 meters, June 1 through October 10, 2002 (concluded).

Date	Maximum	Average	Minimum
28-Aug	21.7	19.7	18.3
29-Aug	20.2	18.9	17.9
30-Aug	20.2	18.6	17.5
31-Aug	21.3	18.8	17.1
1-Sep	22.1	19.4	17.5
2-Sep	22.1	19.9	18.3
3-Sep	21.3	19.5	17.9
4-Sep	20.6	18.8	17.5
5-Sep	20.2	18.2	16.4
6-Sep	19.4	17.7	16.0
7-Sep	19.8	17.5	16.0
8-Sep	19.8	17.4	15.6
9-Sep	20.6	18.1	16.0
10-Sep	20.6	18.5	16.8
11-Sep	20.2	18.3	16.8
12-Sep	19.4	18.0	16.8
13-Sep	19.4	17.9	16.8
14-Sep	19.4	17.9	16.8
15-Sep	18.7	17.8	16.8
16-Sep	19.4	17.7	16.4
17-Sep	20.2	18.5	17.1
18-Sep	21.0	18.9	17.5
19-Sep	20.6	18.9	17.5
20-Sep	20.2	18.6	17.1
21-Sep	20.2	18.4	16.8
22-Sep	20.2	18.4	17.1
23-Sep	20.2	18.3	16.8
24-Sep	19.8	18.2	16.8
25-Sep	19.4	17.9	16.4
26-Sep	18.7	17.6	16.4
27-Sep	17.5	16.9	16.4
28-Sep	17.9	16.0	14.9
29-Sep	17.9	16.3	15.2
30-Sep	17.9	16.3	15.2
1-Oct	17.5	16.1	14.9
2-Oct	17.1	15.7	14.5
3-Oct	17.1	15.4	13.7
4-Oct	17.5	15.9	14.5
5-Oct	18.3	16.5	15.2
6-Oct	18.7	17.0	15.6
7-Oct	19.0	17.3	15.6
8-Oct	19.0	17.3	16.0
9-Oct	18.3	16.9	15.6
10-Oct	20.6	16.6	15.6

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #2 at a depth 3.0 meters, April 6 through October 10, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
6-Apr	16.4	14.6	12.9		19-May	18.3	17.0	16.4
7-Apr	16.8	15.4	14.5		20-May	16.4	15.5	14.9
8-Apr	15.6	15.0	14.5		21-May	17.1	15.7	14.1
9-Apr	14.5	14.2	14.1		22-May	19.0	16.7	14.9
10-Apr	17.1	15.1	13.7		23-May	20.2	17.9	15.6
11-Apr	17.5	16.2	15.2		24-May	21.0	19.0	17.1
12-Apr	18.3	16.6	14.9		25-May	21.3	19.4	17.5
13-Apr	19.4	17.5	15.6		26-May	21.0	19.4	17.9
14-Apr	20.2	18.5	17.1		27-May	20.6	19.0	17.5
15-Apr	17.1	15.8	14.1		28-May	21.7	19.5	17.9
16-Apr	15.2	14.1	13.3		29-May	23.6	21.0	19.0
17-Apr	15.2	13.6	12.2		30-May	24.0	22.2	20.2
18-Apr	15.6	14.2	12.6		31-May	23.6	21.8	20.2
19-Apr	16.8	14.6	12.9		1-Jun	22.9	21.1	19.4
20-Apr	17.5	15.5	13.7		2-Jun	22.1	20.3	18.7
21-Apr	18.3	16.4	14.9		3-Jun	22.1	20.2	18.3
22-Apr	19.0	16.9	14.9		4-Jun	23.2	20.8	18.7
23-Apr	19.4	17.5	15.6		5-Jun	24.4	22.1	20.2
24-Apr	18.7	17.4	16.4		6-Jun	24.0	22.1	20.2
25-Apr	19.0	17.1	15.2		7-Jun	22.5	20.9	19.0
26-Apr	19.0	17.5	16.0		8-Jun	21.3	19.7	17.9
27-Apr	17.5	16.2	14.9		9-Jun	21.0	18.8	16.8
28-Apr	16.4	15.0	13.7		10-Jun	22.5	20.0	17.9
29-Apr	16.0	15.0	14.1		11-Jun	22.9	20.8	19.0
30-Apr	14.5	14.1	13.3		12-Jun	21.7	20.0	18.7
1-May	17.1	14.8	12.9		13-Jun	21.0	19.4	17.9
2-May	17.9	15.9	14.1		14-Jun	21.7	19.8	17.9
3-May	18.3	16.6	15.2		15-Jun	22.1	20.0	17.9
4-May	19.0	16.9	14.9		16-Jun	22.5	20.3	18.3
5-May	19.8	17.7	16.0		17-Jun	22.5	20.6	18.3
6-May	19.8	17.8	16.0		18-Jun	23.6	21.5	19.4
7-May	19.0	17.4	15.6		19-Jun	24.0	21.8	19.8
8-May	19.4	17.4	15.6		20-Jun	23.2	21.5	19.4
9-May	19.4	17.4	15.6		21-Jun	22.5	20.9	19.4
10-May	18.7	16.9	15.2		22-Jun	22.5	20.7	19.0
11-May	19.4	17.4	15.2		23-Jun	22.9	20.8	19.0
12-May	19.8	17.9	16.0		24-Jun	23.2	21.1	19.4
13-May	20.2	18.1	16.4		25-Jun	23.2	21.3	19.4
14-May	20.2	18.2	16.0		26-Jun	22.5	20.9	19.4
15-May	20.6	18.7	16.8		27-Jun	23.2	21.2	19.8
16-May	21.0	18.8	16.8		28-Jun	24.0	21.7	19.8
17-May	21.3	19.0	17.1		29-Jun	24.8	22.3	20.2
18-May	20.2	18.6	17.1		30-Jun	25.6	22.9	21.0

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #2 at a depth 3.0 meters, April 6 through October 10, 2002 (continued).**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
1-Jul	25.6	23.2	21.3		13-Aug	22.1	20.2	19.0
2-Jul	24.4	22.8	21.3		14-Aug	22.1	20.1	19.0
3-Jul	24.0	22.0	20.6		15-Aug	21.3	20.0	19.0
4-Jul	24.0	21.8	19.8		16-Aug	21.0	19.6	18.7
5-Jul	24.0	21.7	19.8		17-Aug	21.0	19.5	18.3
6-Jul	24.4	22.0	20.2		18-Aug	21.0	19.3	18.3
7-Jul	24.4	22.2	20.6		19-Aug	20.6	19.2	18.3
8-Jul	24.8	22.2	20.2		20-Aug	21.0	19.2	17.9
9-Jul	25.6	22.9	21.0		21-Aug	21.3	19.4	17.9
10-Jul	26.0	23.4	21.3		22-Aug	19.4	18.6	18.3
11-Jul	25.2	23.1	21.3		22-Aug	20.2	19.7	18.7
12-Jul	24.0	22.6	21.3		23-Aug	20.2	18.4	17.1
13-Jul	24.0	22.1	20.6		24-Aug	20.6	18.6	17.5
14-Jul	23.6	21.7	20.2		25-Aug	21.3	19.0	17.5
15-Jul	22.9	21.3	19.8		26-Aug	22.1	19.4	17.5
16-Jul	22.1	20.7	19.4		27-Aug	22.1	20.1	18.3
17-Jul	22.5	20.6	19.0		28-Aug	21.7	19.9	18.3
18-Jul	22.9	20.8	19.0		29-Aug	20.2	19.1	18.3
19-Jul	23.6	21.2	19.4		30-Aug	20.6	18.7	17.5
20-Jul	23.6	21.7	20.2		31-Aug	21.3	19.0	17.1
21-Jul	21.7	20.8	20.2		1-Sep	22.1	19.6	17.9
22-Jul	21.7	20.1	19.0		2-Sep	22.5	20.0	18.3
23-Jul	22.5	20.3	19.0		3-Sep	21.7	19.7	18.3
24-Jul	22.9	20.4	18.7		4-Sep	21.0	19.0	17.5
25-Jul	22.1	20.3	19.0		5-Sep	20.6	18.4	16.8
26-Jul	22.9	20.7	19.0		6-Sep	19.8	17.9	16.4
27-Jul	22.9	20.9	19.4		7-Sep	19.8	17.7	16.0
28-Jul	21.7	20.4	19.4		8-Sep	19.8	17.7	16.0
29-Jul	22.1	20.3	19.0		9-Sep	21.0	18.3	16.0
30-Jul	22.5	20.6	19.4		10-Sep	20.6	18.7	17.1
31-Jul	22.5	20.6	19.4		11-Sep	20.2	18.5	17.1
1-Aug	22.5	20.7	19.4		12-Sep	19.8	18.2	16.8
2-Aug	22.5	20.7	19.4		13-Sep	19.4	18.2	16.8
3-Aug	21.0	19.5	19.0		14-Sep	19.4	18.1	16.8
4-Aug	20.6	18.9	17.5		15-Sep	19.0	18.0	17.1
5-Aug	21.3	19.5	17.9		16-Sep	19.8	17.9	16.4
6-Aug	21.7	19.6	17.9		17-Sep	20.2	18.6	17.1
7-Aug	22.1	19.9	17.9		18-Sep	21.0	19.0	17.5
8-Aug	22.9	20.3	18.3		19-Sep	21.0	19.1	17.5
9-Aug	23.2	20.8	18.7		20-Sep	20.6	18.8	17.1
10-Aug	22.9	21.0	19.0		21-Sep	20.2	18.6	17.1
11-Aug	22.5	20.6	19.0		22-Sep	20.2	18.6	17.1
12-Aug	22.1	20.3	18.7		23-Sep	20.2	18.5	16.8

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #2 at a depth 3.0 meters, April 6 through October 10, 2002 (concluded).**

Date	Maximum	Average	Minimum
24-Sep	19.8	18.3	16.8
25-Sep	19.4	18.0	16.8
26-Sep	18.7	17.7	16.8
27-Sep	17.9	17.0	16.4
28-Sep	17.9	16.2	14.9
29-Sep	17.9	16.5	15.2
30-Sep	17.9	16.5	15.2
1-Oct	17.5	16.3	15.2
2-Oct	17.5	15.8	14.5
3-Oct	17.1	15.5	14.1
4-Oct	17.9	16.0	14.5
5-Oct	18.3	16.6	15.2
6-Oct	19.0	17.2	15.6
7-Oct	19.0	17.4	16.0
8-Oct	19.0	17.4	16.0
9-Oct	18.3	17.1	16.0

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #3 at a depth 0.5 meters, June 28 through October 10, 2002 (data logger failed between August 9 and August 22).**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
28-Jun	24.4	21.9	19.8		10-Aug			
29-Jun	25.2	22.6	20.5		11-Aug			
30-Jun	25.6	23.2	20.9		12-Aug			
1-Jul	25.9	23.5	21.3		13-Aug			
2-Jul	24.8	23.1	21.7		14-Aug			
3-Jul	24.0	22.1	20.5		15-Aug			
4-Jul	24.4	22.0	20.2		16-Aug			
5-Jul	24.0	21.9	19.8		17-Aug			
6-Jul	24.4	22.2	20.2		18-Aug			
7-Jul	24.4	22.4	20.5		19-Aug			
8-Jul	25.2	22.4	20.2		20-Aug			
9-Jul	25.6	23.2	20.9		21-Aug			
10-Jul	26.3	23.8	21.7		22-Aug			
11-Jul	25.6	23.5	21.3		23-Aug	20.2	18.6	17.5
12-Jul	24.4	22.9	21.3		24-Aug	20.2	18.7	17.5
13-Jul	24.4	22.3	20.5		25-Aug	21.0	19.0	17.5
14-Jul	24.0	21.9	20.2		26-Aug	22.1	19.5	17.5
15-Jul	23.2	21.4	19.8		27-Aug	22.1	20.2	18.7
16-Jul	22.4	20.8	19.4		28-Aug	21.7	20.1	18.7
17-Jul	22.8	20.8	19.0		29-Aug	20.6	19.3	18.3
18-Jul	23.2	20.9	19.0		30-Aug	20.2	18.9	17.5
19-Jul	24.0	21.5	19.4		31-Aug	21.3	19.1	17.5
20-Jul	24.0	22.0	20.2		1-Sep	22.1	19.8	17.9
21-Jul	22.4	20.9	20.2		2-Sep	22.1	20.2	18.3
22-Jul	22.1	20.2	18.6		3-Sep	21.3	19.9	18.3
23-Jul	22.4	20.5	18.6		4-Sep	21.0	19.2	17.5
24-Jul	22.8	20.6	18.6		5-Sep	20.2	18.5	16.8
25-Jul	22.4	20.5	18.6		6-Sep	19.4	18.0	16.4
26-Jul	22.8	20.9	19.0		7-Sep	19.4	17.9	16.4
27-Jul	23.2	21.1	19.4		8-Sep	19.8	17.7	16.0
28-Jul	21.7	20.5	19.4		9-Sep	21.0	18.4	16.4
29-Jul	22.4	20.5	19.0		10-Sep	20.6	18.8	17.1
30-Jul	22.8	20.8	19.4		11-Sep	20.2	18.7	17.1
31-Jul	22.4	20.8	19.4		12-Sep	19.4	18.4	17.1
1-Aug	22.8	21.0	19.4		13-Sep	19.4	18.3	17.1
2-Aug	22.4	20.8	19.4		14-Sep	19.4	18.2	17.1
3-Aug	21.3	19.6	19.0		15-Sep	19.0	18.1	17.1
4-Aug	20.9	19.0	17.4		16-Sep	19.4	18.0	16.8
5-Aug	21.7	19.5	17.4		17-Sep	20.2	18.7	17.5
6-Aug	22.1	19.7	17.4		18-Sep	20.6	19.1	17.5
7-Aug	22.4	20.0	17.8		19-Sep	20.6	19.2	17.9
8-Aug	21.3	19.5	18.2		20-Sep	20.2	19.0	17.5
9-Aug					21-Sep	20.2	18.7	17.1

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #3 at a depth 0.5 meters, June 28 through October 10, 2002 (data logger failed between August 9 and August 22) (concluded).**

Date	Maximum	Average	Minimum
22-Sep	20.2	18.7	17.5
23-Sep	20.2	18.6	17.1
24-Sep	19.8	18.5	17.1
25-Sep	19.4	18.2	16.8
26-Sep	19.0	17.9	17.1
27-Sep	18.3	17.2	16.8
28-Sep	17.5	16.3	15.2
29-Sep	17.5	16.6	15.2
30-Sep	17.5	16.6	15.6
1-Oct	17.5	16.4	15.2
2-Oct	17.1	15.9	14.5
3-Oct	16.8	15.6	14.1
4-Oct	17.5	16.1	14.9
5-Oct	18.3	16.8	15.6
6-Oct	18.7	17.2	16.0
7-Oct	19.0	17.6	16.0
8-Oct	18.7	17.6	16.4
9-Oct	18.3	17.2	16.0
10-Oct	19.8	16.9	15.6

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #3 at a depth 4.0 meters, April 6 through October 9, 2002 (data logger failed between August 8 and August 23).**

Date	Maximum	Average	Minimum	Date	Maximum	Average	Minimum
28-Jun	24.0	21.9	19.8	10 - Aug			
29-Jun	24.8	22.5	20.5	11-Aug			
30-Jun	25.6	23.1	20.9	12-Aug			
1-Jul	25.9	23.4	21.3	13-Aug			
2-Jul	24.8	23.0	21.3	14-Aug			
3-Jul	24.0	22.0	20.5	15-Aug			
4-Jul	24.0	21.9	20.2	16-Aug			
5-Jul	24.0	21.8	19.8	17-Aug			
6-Jul	24.4	22.1	20.2	18-Aug			
7-Jul	24.4	22.3	20.5	19-Aug			
8-Jul	24.8	22.4	20.2	20-Aug			
9-Jul	25.6	23.0	20.5	21-Aug			
10-Jul	26.3	23.7	21.7	22-Aug			
11-Jul	25.6	23.3	21.3	23-Aug			
12-Jul	24.4	22.8	21.3	24-Aug	20.2	18.7	17.5
13-Jul	24.0	22.2	20.5	25-Aug	21.0	19.1	17.5
14-Jul	24.0	21.9	20.2	26-Aug	21.7	19.5	17.5
15-Jul	23.2	21.4	19.8	27-Aug	22.1	20.3	18.7
16-Jul	22.4	20.8	19.4	28-Aug	21.7	20.2	18.7
17-Jul	22.8	20.7	19.0	29-Aug	20.6	19.3	18.3
18-Jul	22.8	20.9	19.0	30-Aug	20.2	19.0	17.9
19-Jul	24.0	21.4	19.4	31-Aug	21.3	19.2	17.5
20-Jul	24.0	21.9	20.2	1-Sep	22.1	19.8	17.9
21-Jul	22.4	20.9	19.8	2-Sep	22.1	20.3	18.7
22-Jul	21.7	20.1	18.6	3-Sep	21.3	20.0	18.7
23-Jul	22.4	20.4	18.6	4-Sep	21.0	19.3	17.9
24-Jul	22.8	20.6	18.6	5-Sep	20.2	18.6	17.1
25-Jul	22.4	20.5	18.6	6-Sep	19.4	18.0	16.4
26-Jul	22.8	20.9	19.0	7-Sep	19.4	17.9	16.4
27-Jul	23.2	21.0	19.4	8-Sep	19.8	17.8	16.0
28-Jul	21.7	20.5	19.4	9-Sep	21.0	18.4	16.4
29-Jul	22.1	20.5	19.0	10-Sep	20.6	18.9	17.5
30-Jul	22.4	20.7	19.4	11-Sep	20.2	18.8	17.5
31-Jul	22.4	20.8	19.4	12-Sep	19.4	18.4	17.1
1-Aug	22.8	20.9	19.4	13-Sep	19.4	18.3	17.1
2-Aug	22.4	20.8	19.4	14-Sep	19.4	18.2	17.1
3-Aug	21.3	19.5	19.0	15-Sep	19.0	18.2	17.5
4-Aug	20.9	19.0	17.4	16-Sep	19.4	18.1	16.8
5-Aug	21.7	19.5	17.4	17-Sep	20.2	18.7	17.5
6-Aug	21.7	19.6	17.4	18-Sep	20.6	19.2	17.9
7-Aug	22.1	20.0	17.8	19-Sep	20.6	19.2	17.9
8-Aug				20-Sep	20.2	19.0	17.5
9-Aug				21-Sep	20.2	18.8	17.5

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #3 at a depth 4.0 meters, April 6 through October 9, 2002 (data logger failed between August 8 and August 23).**

Date	Maximum	Average	Minimum
22-Sep	20.2	18.8	17.5
23-Sep	20.2	18.7	17.1
24-Sep	19.8	18.6	17.5
25-Sep	19.4	18.2	17.1
26-Sep	19.0	17.9	17.1
27-Sep	18.3	17.3	16.8
28-Sep	17.5	16.3	15.2
29-Sep	17.5	16.6	15.6
30-Sep	17.5	16.6	15.6
1-Oct	17.5	16.5	15.6
2-Oct	17.1	16.0	14.9
3-Oct	16.8	15.7	14.5
4-Oct	17.5	16.1	14.9
5-Oct	18.3	16.8	15.6
6-Oct	18.7	17.3	16.0
7-Oct	19.0	17.6	16.4
8-Oct	18.7	17.6	16.4
9-Oct	18.3	17.3	16.4

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #4 at a depth 0.5 meters, April 6 through October 9, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
6-Jun	24.0	22.8	21.3		20-Jul	23.6	22.3	20.5
7-Jun	23.6	21.8	20.2		21-Jul	23.6	21.2	20.2
8-Jun	22.1	20.4	19.0		22-Jul	21.7	20.5	19.0
9-Jun	20.5	19.2	17.4		23-Jul	22.1	20.7	19.0
10-Jun	22.1	20.4	18.6		24-Jul	22.4	20.8	19.0
11-Jun	22.8	21.4	19.8		25-Jul	22.4	20.9	19.0
12-Jun	21.7	20.5	19.4		26-Jul	22.8	21.2	19.4
13-Jun	20.9	19.8	18.6		27-Jul	22.8	21.4	19.8
14-Jun	21.7	20.0	18.6		28-Jul	22.4	20.9	19.8
15-Jun	21.7	20.4	19.0		29-Jul	22.1	20.8	19.4
16-Jun	22.1	20.7	19.0		30-Jul	22.4	20.9	19.4
17-Jun	22.4	21.0	19.4		31-Jul	22.1	21.0	19.4
18-Jun	23.2	21.9	20.5		1-Aug	22.4	21.3	19.4
19-Jun	23.6	22.3	20.9		2-Aug	22.4	21.2	19.8
20-Jun	23.2	22.1	20.9		3-Aug	22.1	20.0	19.4
21-Jun	22.8	21.5	20.2		4-Aug	20.5	19.2	17.8
22-Jun	22.1	21.1	19.8		5-Aug	21.3	19.7	17.8
23-Jun	22.4	21.2	19.8		6-Aug	21.7	20.0	17.8
24-Jun	22.8	21.5	20.2		7-Aug	22.1	20.3	18.6
25-Jun	22.8	21.8	20.5		8-Aug	23.4	22.2	19.0
26-Jun	22.8	21.5	20.2		9-Aug	23.6	22.8	21.3
27-Jun	23.6	21.6	19.8		10-Aug	24.0	22.9	21.3
28-Jun	24.0	22.1	20.2		11-Aug	23.6	22.1	20.5
29-Jun	24.8	22.8	20.5		12-Aug	23.2	21.8	20.9
30-Jun	25.6	23.4	21.3		13-Aug			
1-Jul	25.6	23.8	21.7		14-Aug			
2-Jul	24.8	23.3	21.7		15-Aug			
3-Jul	24.0	22.4	20.5		16-Aug			
4-Jul	24.0	22.2	20.2		17-Aug			
5-Jul	24.0	22.2	20.2		18-Aug			
6-Jul	24.4	22.4	20.2		19-Aug			
7-Jul	24.4	22.7	20.5		20-Aug			
8-Jul	24.8	22.6	20.5		21-Aug			
9-Jul	25.6	23.4	20.9		22-Aug			
10-Jul	25.9	23.9	21.7		23-Aug	19.8	18.8	17.5
11-Jul	25.6	23.8	21.7		24-Aug	20.2	18.9	17.5
12-Jul	24.8	23.2	21.7		25-Aug	21.0	19.3	17.9
13-Jul	24.0	22.6	20.9		26-Aug	21.7	19.7	17.9
14-Jul	23.6	22.2	20.2		27-Aug	22.1	20.6	19.4
15-Jul	23.2	21.8	20.2		28-Aug	22.1	20.5	19.0
16-Jul	22.4	21.0	19.4		29-Aug	21.3	19.7	18.7
17-Jul	22.4	21.0	19.4		30-Aug	20.2	19.2	18.3
18-Jul	22.8	21.2	19.4		31-Aug	21.3	19.3	17.9
19-Jul	23.6	21.7	19.8		1-Sep	21.7	20.0	18.3

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #4 at a depth 0.5 meters, April 6 through October 9, 2002 (concluded).**

Date	Maximum	Average	Minimum
2-Sep	22.1	20.5	19.0
3-Sep	21.7	20.3	19.0
4-Sep	21.0	19.6	18.3
5-Sep	20.6	18.9	17.5
6-Sep	20.2	18.3	16.8
7-Sep	19.4	18.1	16.8
8-Sep	19.4	18.0	16.8
9-Sep	20.6	18.6	16.8
10-Sep	20.2	19.0	17.9
11-Sep	20.2	19.0	17.9
12-Sep	19.8	18.7	17.9
13-Sep	19.4	18.5	17.5
14-Sep	19.0	18.4	17.5
15-Sep	19.0	18.4	17.9
16-Sep	19.4	18.2	17.1
17-Sep	20.2	18.9	17.9
18-Sep	20.6	19.4	18.3
19-Sep	20.6	19.5	18.7
20-Sep	20.6	19.3	18.3
21-Sep	20.2	19.0	17.9
22-Sep	19.8	19.0	17.9
23-Sep	19.8	18.9	17.9
24-Sep	19.8	18.9	17.9
25-Sep	19.4	18.4	17.5
26-Sep	19.0	18.2	17.5
27-Sep	18.3	17.6	17.1
28-Sep	17.5	16.4	15.6
29-Sep	17.5	16.8	16.0
30-Sep	17.5	16.8	16.0
1-Oct	17.5	16.7	16.0
2-Oct	17.1	16.3	15.6
3-Oct	17.1	15.9	15.2
4-Oct	17.1	16.2	15.6
5-Oct	17.9	16.9	16.0
6-Oct	18.7	17.5	16.8
7-Oct	18.7	17.8	17.1
8-Oct	18.7	17.9	17.1
9-Oct	18.7	17.7	17.1

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #4 at a depth 3.0 meters, April 6 through October 9, 2002 (data logger failed between August 9 and August 22).**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
6-Apr	16.8	14.7	13.3		20-May	16.8	15.8	15.2
7-Apr	16.8	15.6	14.5		21-May	17.5	15.9	14.5
8-Apr	15.6	15.2	14.9		22-May	18.7	16.9	15.2
9-Apr	14.5	14.3	14.1		23-May	20.2	18.1	16.4
10-Apr	17.1	15.2	13.7		24-May	21.0	19.3	17.5
11-Apr	17.5	16.4	15.2		25-May	21.0	19.8	18.3
12-Apr	18.3	16.7	15.2		26-May	21.0	19.7	18.3
13-Apr	19.4	17.7	16.0		27-May	20.2	19.4	18.3
14-Apr	20.6	18.8	17.5		28-May	21.3	19.7	18.3
15-Apr	17.9	16.2	14.5		29-May	23.2	21.1	19.4
16-Apr	16.0	14.4	13.7		30-May	23.6	22.6	21.3
17-Apr	14.9	13.7	12.6		31-May	23.6	22.3	21.0
18-Apr	15.6	14.3	12.9		1-Jun	22.5	21.6	20.2
19-Apr	16.8	14.8	12.9		2-Jun	22.1	20.8	19.0
20-Apr	17.1	15.7	14.1		3-Jun	22.1	20.6	19.0
21-Apr	18.3	16.6	15.2		4-Jun	23.2	21.3	19.4
22-Apr	18.7	17.2	15.6		5-Jun	24.0	22.5	20.6
23-Apr	19.4	17.7	16.0		6-Jun	24.0	22.8	21.3
24-Apr	18.7	17.7	16.8		7-Jun	23.2	21.7	20.2
25-Apr	19.0	17.3	15.6		8-Jun	22.1	20.5	19.4
26-Apr	19.0	17.7	16.4		9-Jun	20.6	19.3	17.5
27-Apr	17.9	16.6	15.6		10-Jun	22.1	20.4	18.7
28-Apr	16.0	15.2	14.1		11-Jun	22.9	21.3	19.8
29-Apr	16.4	15.4	14.5		12-Jun	21.7	20.5	19.4
30-Apr	14.9	14.3	13.7		13-Jun	20.6	19.8	18.7
1-May	17.1	15.0	13.3		14-Jun	21.3	20.0	18.7
2-May	17.9	16.1	14.5		15-Jun	21.7	20.4	19.0
3-May	18.3	16.8	15.6		16-Jun	22.1	20.6	19.0
4-May	18.7	17.1	15.6		17-Jun	22.5	21.0	19.4
5-May	19.8	17.9	16.4		18-Jun	23.2	21.9	20.6
6-May	19.4	18.1	16.4		19-Jun	23.6	22.3	20.6
7-May	19.0	17.8	16.4		20-Jun	23.2	22.1	21.0
8-May	19.0	17.7	16.4		21-Jun	22.5	21.5	20.2
9-May	19.0	17.7	16.0		22-Jun	22.1	21.2	19.8
10-May	18.7	17.4	16.0		23-Jun	22.5	21.3	19.8
11-May	19.4	17.7	16.0		24-Jun	22.9	21.6	20.2
12-May	19.4	18.2	16.8		25-Jun	22.9	21.8	20.6
13-May	20.2	18.5	17.1		26-Jun	22.9	21.5	20.2
14-May	20.2	18.4	16.4		27-Jun	23.6	21.5	19.8
15-May	20.6	19.0	17.1		28-Jun	24.0	22.0	20.2
16-May	21.0	19.2	17.5		29-Jun	24.8	22.7	20.6
17-May	21.0	19.3	17.5		30-Jun	25.6	23.3	21.3
18-May	20.2	18.9	17.5		1-Jul	25.6	23.7	21.7
19-May	19.0	17.4	16.8		2-Jul	25.2	23.3	21.7

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #4 at a depth 3.0 meters, April 6 through October 9, 2002 (data logger failed between August 9 and August 22) (continued).**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
3-Jul	24.0	22.3	20.6		15-Aug			
4-Jul	24.0	22.1	20.2		16-Aug			
5-Jul	24.0	22.1	20.2		17-Aug			
6-Jul	24.4	22.3	20.2		18-Aug			
7-Jul	24.4	22.6	20.6		19-Aug			
8-Jul	24.8	22.6	20.2		20-Aug			
9-Jul	25.6	23.2	21.0		21-Aug			
10-Jul	25.6	23.8	22.1		22-Aug			
11-Jul	25.6	23.8	22.1		23-Aug	20.2	18.6	17.5
12-Jul	24.8	23.3	21.7		24-Aug	20.2	18.7	17.5
13-Jul	24.0	22.6	21.0		25-Aug	21.0	19.1	17.5
14-Jul	23.6	22.2	20.2		26-Aug	21.7	19.5	17.5
15-Jul	23.6	21.9	20.2		27-Aug	22.1	20.3	18.7
16-Jul	22.9	21.2	19.8		28-Aug	21.7	20.2	18.7
17-Jul	22.5	21.0	19.4		29-Aug	20.6	19.3	18.3
18-Jul	22.5	21.1	19.4		30-Aug	20.2	19.0	17.9
19-Jul	23.2	21.5	19.8		31-Aug	21.3	19.2	17.5
20-Jul	23.6	22.2	20.6		1-Sep	22.1	19.8	17.9
21-Jul	23.6	21.3	20.2		2-Sep	22.1	20.3	18.7
22-Jul	21.7	20.4	19.0		3-Sep	21.3	20.0	18.7
23-Jul	22.1	20.6	19.0		4-Sep	21.0	19.3	17.9
24-Jul	22.5	20.8	19.0		5-Sep	20.2	18.6	17.1
25-Jul	22.5	20.8	19.4		6-Sep	19.4	18.0	16.4
26-Jul	22.5	21.0	19.4		7-Sep	19.4	17.9	16.4
27-Jul	22.5	21.3	19.8		8-Sep	19.8	17.8	16.0
28-Jul	22.5	20.8	19.8		9-Sep	21.0	18.4	16.4
29-Jul	21.7	20.7	19.4		10-Sep	20.6	18.9	17.5
30-Jul	22.1	20.9	19.4		11-Sep	20.2	18.8	17.5
31-Jul	22.1	21.0	19.8		12-Sep	19.4	18.4	17.1
1-Aug	22.5	21.2	19.8		13-Sep	19.4	18.3	17.1
2-Aug	22.5	21.2	20.2		14-Sep	19.4	18.2	17.1
3-Aug	22.1	20.2	19.4		15-Sep	19.0	18.2	17.5
4-Aug	20.6	19.2	18.3		16-Sep	19.4	18.1	16.8
5-Aug	21.3	19.6	18.3		17-Sep	20.2	18.7	17.5
6-Aug	21.3	19.9	18.3		18-Sep	20.6	19.2	17.9
7-Aug	21.7	20.2	18.7		19-Sep	20.6	19.2	17.9
8-Aug	21.7	20.3	19.0		20-Sep	20.2	19.0	17.5
9-Aug					21-Sep	20.2	18.8	17.5
10-Aug					22-Sep	20.2	18.8	17.5
11-Aug					23-Sep	20.2	18.7	17.1
12-Aug					24-Sep	19.8	18.6	17.5
13-Aug					25-Sep	19.4	18.2	17.1
14-Aug					26-Sep	19.0	17.9	17.1

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #4 at a depth 3.0 meters, April 6 through October 9, 2002 (data logger failed between August 9 and August 22) (concluded).**

Date	Maximum	Average	Minimum
27-Sep	18.3	17.3	16.8
28-Sep	17.5	16.3	15.2
29-Sep	17.5	16.6	15.6
30-Sep	17.5	16.6	15.6
1-Oct	17.5	16.5	15.6
2-Oct	17.1	16.0	14.9
3-Oct	16.8	15.7	14.5
4-Oct	17.5	16.1	14.9
5-Oct	18.3	16.8	15.6
6-Oct	18.7	17.3	16.0
7-Oct	19.0	17.6	16.4
8-Oct	18.7	17.6	16.4
9-Oct	18.3	17.3	16.4

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #5 at a depth 0.5 meters, June 1 through October 10, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
1-Jun	22.5	22.1	21.3		13-Jul	24.0	23.2	22.9
2-Jun	22.1	21.2	20.2		14-Jul	23.2	22.8	22.1
3-Jun	22.1	20.8	19.4		15-Jul	22.5	22.4	22.1
4-Jun	22.5	21.5	20.2		16-Jul	22.1	21.7	21.0
5-Jun	24.4	23.0	22.1		17-Jul	22.1	21.3	20.6
6-Jun	24.4	23.5	22.9		18-Jul	22.5	21.6	21.0
7-Jun	23.6	22.6	22.1		19-Jul	23.2	22.0	21.3
8-Jun	22.1	21.2	20.2		20-Jul	23.6	22.6	22.1
9-Jun	20.2	19.6	19.0		21-Jul	22.9	21.9	20.6
10-Jun	21.7	20.5	19.8		22-Jul	21.7	20.7	20.6
11-Jun	22.9	21.6	20.6		23-Jul	21.7	21.0	20.6
12-Jun	22.1	21.1	20.2		24-Jul	22.1	21.1	20.6
13-Jun	21.0	20.2	19.4		25-Jul	21.7	21.3	20.6
14-Jun	21.7	20.3	19.8		26-Jul	22.5	21.5	21.0
15-Jun	21.7	20.9	20.2		27-Jul	22.9	21.8	21.3
16-Jun	22.5	21.0	20.6		28-Jul	22.1	21.5	21.0
17-Jun	22.1	21.5	21.0		29-Jul	22.1	21.0	20.6
18-Jun	23.2	22.3	21.3		30-Jul	22.1	21.3	21.0
19-Jun	23.2	22.7	22.5		31-Jul	22.1	21.5	21.0
20-Jun	23.2	22.7	22.5		1-Aug	22.5	21.6	21.0
21-Jun	22.9	22.1	21.7		2-Aug	22.1	21.6	21.3
22-Jun	22.1	21.6	21.3		3-Aug	21.7	20.9	19.4
23-Jun	23.2	21.7	21.3		4-Aug	20.6	19.5	19.0
24-Jun	23.6	22.1	21.3		5-Aug	20.2	19.9	19.4
25-Jun	23.6	22.3	21.7		6-Aug	21.3	20.3	19.8
26-Jun	23.2	22.2	21.7		7-Aug	22.1	20.7	20.2
27-Jun	23.2	22.2	21.3		8-Aug	22.1	21.2	20.2
28-Jun	23.6	22.4	22.1		9-Aug	22.9	21.8	21.0
29-Jun	24.4	23.2	22.9		10-Aug	23.6	22.3	21.3
30-Jun	24.8	23.8	23.2		11-Aug	23.2	22.1	21.7
1-Jul	25.2	24.3	23.2		12-Aug	22.9	21.5	21.0
2-Jul	24.8	24.0	23.6		13-Aug	22.1	21.3	21.0
3-Jul	23.6	23.0	22.1		14-Aug	22.1	21.2	21.0
4-Jul	23.2	22.7	22.1		15-Aug	21.7	21.1	20.6
5-Jul	22.9	22.7	22.1		16-Aug	21.3	20.7	20.6
6-Jul	23.2	22.8	22.1		17-Aug	20.6	20.3	20.2
7-Jul	23.6	23.2	22.9		18-Aug	20.6	20.2	19.8
8-Jul	23.6	23.0	22.5		19-Aug	20.2	19.9	19.4
9-Jul	24.4	23.6	23.2		20-Aug	20.2	19.8	19.0
10-Jul	25.6	24.4	23.6		21-Aug	21.0	20.2	19.8
11-Jul	25.2	24.4	24.0		22-Aug	21.7	20.0	19.4
12-Jul	24.0	23.8	23.2		23-Aug	19.4	19.2	18.7

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #5 at a depth 0.5 meters, June 1 through October 10, 2002.**

Date	Maximum	Average	Minimum	Date	Maximum	Average	Minimum
23-Aug	19.4	19.2	18.7	6-Oct	18.7	17.6	16.8
24-Aug	19.8	19.2	18.7	7-Oct	18.7	18.0	17.5
25-Aug	20.6	19.5	19.0	8-Oct	18.7	17.9	17.5
26-Aug	21.0	19.9	19.4	9-Oct	18.7	17.9	17.5
27-Aug	21.7	20.9	20.2	10-Oct	21.0	17.6	17.1
28-Aug	21.7	21.1	20.6				
29-Aug	20.6	20.2	19.4				
30-Aug	20.2	19.5	19.0				
31-Aug	20.6	19.6	19.0				
1-Sep	21.0	20.3	19.8				
2-Sep	21.7	20.9	20.2				
3-Sep	21.7	20.8	20.6				
4-Sep	20.6	20.1	19.8				
5-Sep	20.6	19.5	19.0				
6-Sep	19.4	18.9	18.3				
7-Sep	19.0	18.5	17.9				
8-Sep	19.4	18.5	17.9				
9-Sep	19.4	18.4	17.9				
10-Sep	20.6	19.6	19.0				
11-Sep	20.2	19.3	19.0				
12-Sep	19.4	19.1	18.7				
13-Sep	19.4	18.9	18.7				
14-Sep	19.0	18.7	18.7				
15-Sep	19.0	18.7	18.3				
16-Sep	19.0	18.3	17.9				
17-Sep	19.4	18.9	18.3				
18-Sep	21.0	19.6	19.0				
19-Sep	21.3	20.0	19.4				
20-Sep	20.6	19.7	19.4				
21-Sep	20.6	19.5	19.0				
22-Sep	20.2	19.3	18.7				
23-Sep	20.2	19.3	18.7				
24-Sep	20.2	19.2	18.7				
25-Sep	19.8	18.9	18.3				
26-Sep	18.7	18.3	17.9				
27-Sep	18.3	17.8	17.5				
28-Sep	17.5	16.7	16.4				
29-Sep	17.5	16.7	16.0				
30-Sep	17.5	16.9	16.4				
1-Oct	17.1	16.8	16.4				
2-Oct	16.8	16.4	16.0				
3-Oct	17.1	16.1	15.6				
4-Oct	17.5	16.3	15.6				
5-Oct	18.3	16.9	16.0				

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #5 at a depth 3.0 meters, June 1 through October 10, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
1-Jun	22.4	21.8	20.9		14-Jul	22.8	22.3	21.7
2-Jun	22.1	21.0	19.8		15-Jul	22.4	22.0	21.3
3-Jun	21.7	20.4	19.0		16-Jul	22.1	21.2	20.2
4-Jun	22.1	21.0	20.2		17-Jul	21.3	20.9	20.2
5-Jun	22.8	22.2	21.7		18-Jul	21.7	21.1	20.5
6-Jun	23.6	23.0	22.4		19-Jul	22.1	21.5	20.9
7-Jun	23.2	22.2	21.7		20-Jul	22.4	22.1	21.7
8-Jun	21.7	21.0	20.2		21-Jul	22.4	21.6	20.5
9-Jun	19.8	19.3	18.6		22-Jul	20.5	20.3	19.8
10-Jun	21.3	20.2	19.4		23-Jul	20.9	20.5	20.2
11-Jun	22.1	21.2	20.2		24-Jul	21.3	20.7	20.2
12-Jun	22.1	20.8	19.8		25-Jul	21.7	20.9	20.2
13-Jun	20.5	19.9	19.0		26-Jul	21.3	21.0	20.5
14-Jun	20.9	19.9	19.4		27-Jul	21.7	21.3	20.9
15-Jun	20.9	20.4	20.2		28-Jul	21.7	21.2	20.5
16-Jun	21.3	20.5	20.2		29-Jul	20.9	20.6	20.2
17-Jun	21.7	21.1	20.9		30-Jul	20.9	20.8	20.5
18-Jun	22.4	21.8	21.3		31-Jul	21.3	21.0	20.5
19-Jun	22.8	22.3	22.1		1-Aug	21.3	21.1	20.5
20-Jun	22.4	22.3	22.1		2-Aug	21.7	21.3	20.9
21-Jun	22.1	21.8	21.3		3-Aug	21.3	20.6	19.4
22-Jun	21.7	21.3	20.9		4-Aug	19.8	19.2	19.0
23-Jun	22.1	21.2	20.9		5-Aug	19.8	19.6	19.4
24-Jun	22.1	21.5	21.3		6-Aug	20.2	19.9	19.4
25-Jun	22.4	21.9	21.7		7-Aug	20.5	20.2	19.8
26-Jun	22.1	21.8	21.7		8-Aug	20.9	20.5	20.2
27-Jun	22.1	21.2	20.9		9-Aug	21.7	21.1	20.5
28-Jun	22.4	22.0	21.7		10-Aug	22.1	21.7	21.3
29-Jun	23.2	22.6	22.1		11-Aug	21.7	21.3	20.9
30-Jun	24.0	23.3	22.8		12-Aug	21.3	20.9	20.5
1-Jul	24.4	23.8	22.8		13-Aug	21.3	20.8	20.2
2-Jul	24.4	23.7	22.8		14-Aug	20.9	20.6	20.2
3-Jul	23.2	22.6	21.7		15-Aug	21.3	20.6	20.2
4-Jul	22.8	22.3	21.7		16-Aug	20.9	20.2	19.8
5-Jul	22.8	22.1	21.3		17-Aug	20.2	19.9	19.4
6-Jul	22.8	22.2	21.7		18-Aug	20.2	19.7	19.0
7-Jul	23.2	22.7	22.1		19-Aug	20.2	19.5	19.0
8-Jul	23.2	22.5	22.1		20-Aug	19.8	19.3	18.6
9-Jul	23.6	23.1	22.4		21-Aug	20.2	19.8	19.0
10-Jul	24.0	23.8	23.6		22-Aug	20.2	19.5	18.6
11-Jul	24.4	24.0	23.6		23-Aug	19.4	18.7	17.8
12-Jul	24.0	23.5	22.8		24-Aug	19.0	18.7	18.2
13-Jul	23.2	22.7	22.1		25-Aug	19.4	19.0	18.6

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #5 at a depth 3.0 meters, June 1 through October10, 2002 (concluded).**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
26-Aug	19.8	19.4	19.0		9-Oct	17.8	17.5	17.4
27-Aug	20.9	20.3	19.8					
28-Aug	20.9	20.6	20.2					
29-Aug	20.5	19.9	19.4					
30-Aug	19.4	19.1	18.6					
31-Aug	19.4	19.0	18.6					
1-Sep	20.2	19.8	19.4					
2-Sep	20.9	20.3	20.2					
3-Sep	20.9	20.3	19.8					
4-Sep	20.2	19.7	19.0					
5-Sep	19.4	19.0	18.6					
6-Sep	19.0	18.4	18.2					
7-Sep	18.2	18.0	17.8					
8-Sep	18.2	17.9	17.4					
9-Sep	18.6	18.1	17.4					
10-Sep	19.8	19.2	18.6					
11-Sep	19.4	19.0	18.6					
12-Sep	19.0	18.7	18.2					
13-Sep	19.0	18.5	18.2					
14-Sep	18.6	18.4	18.2					
15-Sep	18.6	18.4	18.2					
16-Sep	18.6	18.0	17.8					
17-Sep	19.4	18.7	18.2					
18-Sep	19.8	19.2	19.0					
19-Sep	19.8	19.5	19.4					
20-Sep	19.4	19.3	19.0					
21-Sep	19.4	19.0	18.6					
22-Sep	19.4	18.9	18.6					
23-Sep	19.0	18.7	18.6					
24-Sep	19.0	18.7	18.6					
25-Sep	18.6	18.3	18.2					
26-Sep	18.2	18.1	17.8					
27-Sep	17.8	17.5	17.1					
28-Sep	17.1	16.4	16.3					
29-Sep	17.1	16.4	15.9					
30-Sep	17.1	16.5	16.3					
1-Oct	16.7	16.5	16.3					
2-Oct	16.3	16.1	15.9					
3-Oct	15.9	15.7	15.6					
4-Oct	16.3	15.9	15.6					
5-Oct	17.1	16.5	15.9					
6-Oct	17.8	17.1	16.7					
7-Oct	17.8	17.5	17.1					
8-Oct	17.8	17.6	17.4					

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #6 at a depth 1.5 meters, March 9 through December 9, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
9-Mar	11.0	10.7	10.2		22-Apr	16.0	15.2	14.5
10-Mar	11.8	11.2	10.6		23-Apr	18.7	17.3	16.0
11-Mar	12.9	11.9	11.0		24-Apr	18.7	16.6	12.9
12-Mar	12.9	12.6	12.2		25-Apr	16.0	13.5	12.9
13-Mar	12.6	11.8	11.0		26-Apr	17.5	14.4	12.9
14-Mar	12.2	11.3	10.2		27-Apr	16.4	15.2	13.3
15-Mar	12.2	11.4	10.6		28-Apr	15.6	14.8	14.1
16-Mar	11.8	11.2	10.2		29-Apr	16.4	15.5	14.5
17-Mar	12.2	11.4	10.6		30-Apr	14.9	13.6	13.3
18-Mar	12.2	11.3	10.2		1-May	13.7	13.4	13.3
19-Mar	13.3	12.1	10.6		2-May	13.7	13.7	13.3
20-Mar	14.1	12.9	11.4		3-May	13.7	13.7	13.7
21-Mar	14.1	13.2	12.6		4-May	13.7	13.7	13.7
22-Mar	13.7	13.1	12.6		5-May	13.7	13.7	13.7
23-Mar	13.3	12.4	11.8		6-May	14.1	13.9	13.7
24-Mar	13.3	12.5	11.4		7-May	14.1	14.1	14.1
25-Mar	12.9	12.4	11.8		8-May	14.1	14.1	14.1
26-Mar	13.7	12.5	11.4		9-May	14.1	14.1	14.1
27-Mar	14.9	13.5	12.2		10-May	14.1	14.1	14.1
28-Mar	16.0	14.5	13.3		11-May	14.1	14.1	14.1
29-Mar	16.4	15.3	14.1		12-May	14.1	14.1	14.1
30-Mar	17.1	15.8	14.5		13-May	14.5	14.2	14.1
31-Mar	17.1	16.0	14.9		14-May	19.8	17.4	14.1
1-Apr	18.3	15.7	14.9		15-May	21.0	19.1	17.5
2-Apr	16.8	15.9	15.2		16-May	20.6	19.4	17.9
3-Apr	15.6	14.8	14.1		17-May	20.6	19.5	17.9
4-Apr	14.5	13.9	13.7		18-May	20.2	19.2	18.3
5-Apr	14.1	13.7	13.3		19-May	19.0	17.6	16.8
6-Apr	16.4	14.6	12.9		20-May	16.4	15.8	15.2
7-Apr	16.8	15.6	14.5		21-May	16.8	15.7	14.5
8-Apr	15.6	15.1	14.5		22-May	16.8	15.9	14.9
9-Apr	14.5	14.2	13.7		23-May	15.2	15.2	15.2
10-Apr	16.8	15.1	13.7		24-May	15.2	15.2	15.2
11-Apr	17.5	16.3	15.2		25-May	15.6	15.3	15.2
12-Apr	18.3	16.7	15.2		26-May	15.6	15.3	15.2
13-Apr	19.4	17.7	16.0		27-May	15.6	15.5	15.2
14-Apr	20.6	18.8	17.5		28-May	16.0	15.8	15.6
15-Apr	17.5	15.7	14.5		29-May	22.5	19.5	16.0
16-Apr	16.4	14.7	14.1		30-May	23.2	22.2	16.8
17-Apr	14.5	13.6	12.6		31-May	22.9	22.6	22.1
18-Apr	15.2	14.2	12.9		1-Jun	22.1	21.7	21.0
19-Apr	15.6	14.5	13.3		2-Jun	21.3	20.4	19.4
20-Apr	16.0	15.2	14.5		3-Jun	21.7	20.3	18.7
21-Apr	16.4	15.6	14.9		4-Jun	22.1	21.3	20.2

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #6 at a depth 1.5 meters, March 9 through December 9, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
5-Jun	24.0	22.7	21.7		19-Jul	22.1	21.7	21.3
6-Jun	24.0	23.3	22.9		20-Jul	22.9	22.3	22.1
7-Jun	22.9	22.3	21.7		21-Jul	22.5	21.6	20.6
8-Jun	21.7	20.9	19.8		22-Jul	20.6	20.4	20.2
9-Jun	19.8	19.3	18.7		23-Jul	21.3	20.6	20.2
10-Jun	21.7	20.3	19.4		24-Jul	21.3	20.9	20.2
11-Jun	23.2	21.5	20.6		25-Jul	21.3	21.0	20.6
12-Jun	21.7	20.8	20.2		26-Jul	21.7	21.3	21.0
13-Jun	20.6	19.9	19.4		27-Jul	21.7	21.5	21.3
14-Jun	21.3	20.0	19.4		28-Jul	21.7	21.1	20.6
15-Jun	21.7	20.6	20.2		29-Jul	21.3	20.7	20.2
16-Jun	21.7	20.7	20.2		30-Jul	21.3	21.0	20.6
17-Jun	22.1	21.3	20.6		31-Jul	21.3	21.2	21.0
18-Jun	23.6	22.1	21.3		1-Aug	21.7	21.3	21.0
19-Jun	23.6	22.6	22.1		2-Aug	21.7	21.4	21.0
20-Jun	23.2	22.5	22.1		3-Aug	21.3	20.6	19.4
21-Jun	23.2	22.0	21.7		4-Aug	19.8	19.3	19.0
22-Jun	22.5	21.6	21.3		5-Aug	20.2	19.6	19.4
23-Jun	22.5	21.6	21.0		6-Aug	20.6	20.1	19.8
24-Jun	22.9	21.9	21.3		7-Aug	21.0	20.3	19.8
25-Jun	23.2	22.1	21.3		8-Aug	21.3	20.7	20.2
26-Jun	22.5	22.0	21.7		9-Aug	22.1	21.4	20.6
27-Jun	22.5	21.6	21.0		10-Aug	22.1	21.8	21.3
28-Jun	22.5	22.2	21.7		11-Aug	21.7	21.6	21.3
29-Jun	23.2	22.8	22.5		12-Aug	21.3	21.0	20.6
30-Jun	24.0	23.5	23.2		13-Aug	21.3	20.9	20.6
1-Jul	24.4	24.0	23.2		14-Aug	21.0	20.8	20.6
2-Jul	24.4	23.7	23.2		15-Aug	21.0	20.7	20.2
3-Jul	23.2	22.7	22.1		16-Aug	20.6	20.3	19.8
4-Jul	22.9	22.3	21.7		17-Aug	20.2	20.0	19.4
5-Jul	22.5	22.3	21.7		18-Aug	20.2	19.8	19.4
6-Jul	22.9	22.5	22.1		19-Aug	20.2	19.5	19.0
7-Jul	23.2	22.8	22.5		20-Aug	19.8	19.4	19.0
8-Jul	23.2	22.7	22.1		21-Aug	20.2	19.8	19.4
9-Jul	23.6	23.3	22.9		22-Aug	20.2	19.6	19.0
10-Jul	24.4	24.0	23.6		23-Aug	19.0	18.8	18.3
11-Jul	24.4	24.0	23.6		24-Aug	19.0	18.9	18.7
12-Jul	24.0	23.5	23.2		25-Aug	19.4	19.2	19.0
13-Jul	23.2	22.9	22.5		26-Aug	20.2	19.6	19.4
14-Jul	22.9	22.4	22.1		27-Aug	21.0	20.5	19.8
15-Jul	22.5	22.0	21.7		28-Aug	21.0	20.7	20.2
16-Jul	21.7	21.3	20.6		29-Aug	20.6	19.9	19.4
17-Jul	21.3	21.0	20.6		30-Aug	19.4	19.2	19.0
18-Jul	21.7	21.3	21.0		31-Aug	19.8	19.2	19.0

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #6 at a depth 1.5 meters, March 9 through December 9, 2002 (continued).**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
1-Sep	20.2	20.0	19.4		15-Oct	16.0	15.8	15.6
2-Sep	21.0	20.5	20.2		16-Oct	15.6	15.4	15.2
3-Sep	21.0	20.4	20.2		17-Oct	15.2	15.0	14.9
4-Sep	20.2	19.8	19.4		18-Oct	15.2	14.7	14.5
5-Sep	19.4	19.1	18.7		19-Oct	16.0	15.3	14.9
6-Sep	18.7	18.5	17.9		20-Oct	16.4	15.9	15.2
7-Sep	18.3	18.2	17.9		21-Oct	16.4	16.0	16.0
8-Sep	18.3	18.1	17.9		22-Oct	16.0	15.6	15.2
9-Sep	19.0	18.2	17.9		23-Oct	15.2	14.8	14.5
10-Sep	19.8	19.3	19.0		24-Oct	15.2	14.6	14.1
11-Sep	19.4	19.1	18.7		25-Oct	15.2	14.5	14.1
12-Sep	19.0	19.0	18.7		26-Oct	15.2	14.8	14.5
13-Sep	19.0	18.6	18.3		27-Oct	14.9	14.3	14.1
14-Sep	18.7	18.5	18.3		28-Oct	14.5	13.8	13.3
15-Sep	18.7	18.5	18.3		29-Oct	14.1	13.8	13.3
16-Sep	18.7	18.2	17.9		30-Oct	13.7	13.1	12.9
17-Sep	19.4	18.8	18.3		31-Oct	12.6	12.3	11.8
18-Sep	19.8	19.4	19.0		1-Nov	12.2	11.8	11.4
19-Sep	20.2	19.6	19.0		2-Nov	11.8	11.6	11.0
20-Sep	19.8	19.4	19.0		3-Nov	12.2	11.7	11.4
21-Sep	19.4	19.1	18.7		4-Nov	12.6	12.1	11.4
22-Sep	19.4	19.0	18.7		5-Nov	12.6	12.3	12.2
23-Sep	19.4	19.0	18.7		6-Nov	13.3	12.7	12.2
24-Sep	19.4	18.8	18.3		7-Nov	14.1	13.8	13.3
25-Sep	19.0	18.5	18.3		8-Nov	14.5	13.9	13.3
26-Sep	18.7	18.2	17.9		9-Nov	14.1	13.7	13.3
27-Sep	17.9	17.6	17.5		10-Nov	14.1	13.9	13.3
28-Sep	17.1	16.5	16.4		11-Nov	14.1	13.6	13.3
29-Sep	17.1	16.5	16.0		12-Nov	14.1	13.8	13.7
30-Sep	17.1	16.6	16.4		13-Nov	13.7	13.4	12.9
1-Oct	16.8	16.5	16.4		14-Nov	13.3	13.0	12.6
2-Oct	16.4	16.1	16.0		15-Nov	12.9	12.6	12.6
3-Oct	16.0	15.9	15.6		16-Nov	12.9	12.4	12.2
4-Oct	16.8	16.0	15.2		17-Nov	12.6	12.5	12.2
5-Oct	17.5	16.7	16.0		18-Nov	12.2	12.1	11.8
6-Oct	17.9	17.4	16.8		19-Nov	12.6	12.1	11.8
7-Oct	18.3	17.7	17.1		20-Nov	12.9	12.5	12.2
8-Oct	18.3	17.8	17.5		21-Nov	12.9	12.6	12.6
9-Oct	17.9	17.6	17.1		22-Nov	12.9	12.7	12.6
10-Oct	17.5	17.0	16.8		23-Nov	13.3	13.0	12.9
11-Oct	17.1	16.7	16.4		24-Nov	12.9	12.7	12.6
12-Oct	16.8	16.4	16.0		25-Nov	12.6	12.3	12.2
13-Oct	16.4	16.0	15.6		26-Nov	12.2	12.1	11.8
14-Oct	16.4	15.9	15.6		27-Nov	11.8	11.7	11.4

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #6 at a depth 1.5 meters, March 9 through December 9, 2002 (concluded).**

Date	Maximum	Average	Minimum
28-Nov	11.4	11.2	11.0
29-Nov	10.6	10.6	10.2
30-Nov	11.0	10.6	10.2
1-Dec	11.4	11.1	11.0
2-Dec	11.0	11.0	10.6
3-Dec	11.4	11.0	10.6
4-Dec	11.4	11.4	11.4
5-Dec	11.4	11.0	11.0
6-Dec	11.0	11.0	11.0
7-Dec	11.0	10.9	10.6
8-Dec	11.0	10.8	10.6
9-Dec	12.2	11.4	11.0

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #7 at a depth 0.5 meters, June 6 through September 1, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
6-Jun	25.6	23.6	22.4		20-Jul	22.8	21.9	20.5
7-Jun	24.8	22.9	21.7		21-Jul	22.4	20.9	20.2
8-Jun	23.2	21.5	20.5		22-Jul	22.8	21.0	19.8
9-Jun	21.3	20.0	19.0		23-Jul	23.2	21.2	19.8
10-Jun	22.1	20.5	19.4		24-Jul	23.2	21.3	20.2
11-Jun	22.8	21.6	20.5		25-Jul	23.6	21.6	20.2
12-Jun	22.1	21.1	20.5		26-Jul	23.6	21.8	20.5
13-Jun	22.1	20.4	19.8		27-Jul	22.8	21.4	20.5
14-Jun	22.1	20.3	19.0		28-Jul	22.8	21.1	20.2
15-Jun	22.4	20.8	19.4		29-Jul	23.2	21.3	20.2
16-Jun	22.8	20.9	19.4		30-Jul	23.2	21.4	20.5
17-Jun	23.6	21.6	19.8		31-Jul	23.6	21.5	20.5
18-Jun	24.0	22.3	20.5		1-Aug	23.6	21.7	20.5
19-Jun	24.8	22.7	21.3		2-Aug	21.3	20.8	19.8
20-Jun	24.4	22.7	21.3		3-Aug	21.3	19.8	19.0
21-Jun	23.6	22.1	20.9		4-Aug	22.1	20.1	18.6
22-Jun	23.2	21.6	20.5		5-Aug	22.4	20.3	18.6
23-Jun	23.2	21.6	20.2		6-Aug	22.8	20.7	19.0
24-Jun	24.0	21.9	20.5		7-Aug	23.2	21.1	19.4
25-Jun	24.0	22.1	20.5		8-Aug	24.0	21.7	19.8
26-Jun	24.0	22.1	20.9		9-Aug	24.8	22.2	20.5
27-Jun	24.0	22.0	20.5		10-Aug	24.0	22.0	20.5
28-Jun	24.4	22.4	21.3		11-Aug	23.6	21.6	20.2
29-Jun	25.2	23.1	21.7		12-Aug	23.2	21.3	20.2
30-Jun	25.9	23.9	22.4		13-Aug	22.8	21.2	20.2
1-Jul	26.3	24.3	23.2		14-Aug	22.4	21.1	20.2
2-Jul	25.6	24.0	22.8		15-Aug	22.1	20.7	20.2
3-Jul	24.8	23.1	22.1		16-Aug	21.7	20.4	19.4
4-Jul	24.8	22.8	21.3		17-Aug	21.7	20.1	19.4
5-Jul	24.8	22.7	21.3		18-Aug	20.9	19.9	19.4
6-Jul	24.8	22.8	21.3		19-Aug	20.9	19.8	19.0
7-Jul	25.2	23.1	21.7		20-Aug	21.7	20.1	19.4
8-Jul	25.2	23.1	21.7		21-Aug	20.9	19.8	19.0
9-Jul	25.9	23.6	22.1		22-Aug	20.2	19.1	18.6
10-Jul	26.7	24.3	22.4		23-Aug	20.5	19.1	18.2
11-Jul	26.7	24.4	22.8		24-Aug	20.9	19.4	18.6
12-Jul	25.9	24.1	22.8		25-Aug	21.7	20.0	18.6
13-Jul	25.2	23.4	22.4		26-Aug	22.8	20.8	19.4
14-Jul	24.8	23.0	21.7		27-Aug	22.8	21.1	19.8
15-Jul	24.0	22.4	21.3		28-Aug	21.3	20.2	19.4
16-Jul	23.2	21.7	20.9		29-Aug	20.9	19.6	18.6
17-Jul	23.2	21.4	20.5		30-Aug	21.3	19.6	18.6
18-Jul	23.6	21.6	20.5		31-Aug	22.1	20.3	19.0
19-Jul	24.0	22.0	20.5		1-Sep	22.8	20.8	19.4

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #7 at a depth 2.0 meters, June 6 through September 1, 2002.**

Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
6-Apr	16.0	14.5	12.9		19-May	18.7	17.7	16.8
7-Apr	16.4	15.5	14.5		20-May	16.4	15.8	15.2
8-Apr	16.0	15.2	14.9		21-May	16.8	15.5	14.5
9-Apr	14.5	14.2	14.1		22-May	17.5	16.6	16.0
10-Apr	16.4	15.0	13.7		23-May	18.7	17.7	16.8
11-Apr	17.1	16.3	15.2		24-May	19.8	19.0	18.3
12-Apr	18.3	16.7	15.2		25-May	20.2	19.6	19.0
13-Apr	19.0	17.6	16.0		26-May	20.2	19.6	19.0
14-Apr	20.2	18.8	17.5		27-May	19.8	19.4	19.0
15-Apr	18.3	16.3	14.9		28-May	20.6	19.6	18.7
16-Apr	16.4	14.7	14.1		29-May	22.5	21.0	19.8
17-Apr	14.1	13.6	12.9		30-May	24.4	22.6	21.3
18-Apr	14.9	14.0	13.3		31-May	23.6	22.6	21.7
19-Apr	15.6	14.5	13.3		1-Jun	22.5	21.8	21.3
20-Apr	16.0	15.5	14.5		2-Jun	21.7	21.0	20.2
21-Apr	17.1	16.4	15.6		3-Jun	22.1	20.6	19.4
22-Apr	17.5	17.0	16.0		4-Jun	22.5	21.4	20.2
23-Apr	18.3	17.6	16.8		5-Jun	24.8	22.9	21.7
24-Apr	18.3	17.6	17.1		6-Jun	25.2	23.4	22.1
25-Apr	17.9	17.3	16.4		7-Jun	24.4	22.7	21.7
26-Apr	18.3	17.6	16.8		8-Jun	22.9	21.4	20.2
27-Apr	17.9	16.9	16.4		9-Jun	21.3	19.9	18.7
28-Apr	16.4	15.1	14.5		10-Jun	22.1	20.4	19.0
29-Apr	16.4	15.5	14.5		11-Jun	22.9	21.5	20.2
30-Apr	15.6	14.5	14.1		12-Jun	21.7	21.0	20.2
1-May	15.6	14.6	13.7		13-Jun	21.7	20.3	19.4
2-May	16.8	15.8	14.9		14-Jun	22.1	20.2	19.0
3-May	17.1	16.6	16.0		15-Jun	22.5	20.6	19.0
4-May	17.5	16.9	16.0		16-Jun	22.5	20.9	19.4
5-May	18.7	17.8	16.8		17-Jun	23.2	21.4	19.8
6-May	18.7	18.2	17.5		18-Jun	24.0	22.1	20.6
7-May	18.7	17.9	17.1		19-Jun	24.4	22.7	21.3
8-May	18.3	17.7	17.1		20-Jun	24.4	22.6	21.0
9-May	18.3	17.7	17.1		21-Jun	23.6	21.9	20.6
10-May	17.9	17.5	17.1		22-Jun	22.9	21.5	20.6
11-May	18.3	17.5	16.8		23-Jun	23.2	21.5	20.2
12-May	18.7	18.0	17.5		24-Jun	23.6	21.8	20.2
13-May	19.0	18.4	17.5		25-Jun	23.6	22.0	20.6
14-May	19.4	18.4	16.8		26-Jun	23.6	22.0	20.6
15-May	20.2	18.9	17.5		27-Jun	23.6	21.9	20.6
16-May	20.2	19.3	18.3		28-Jun	24.0	22.2	21.0
17-May	20.2	19.4	18.3		29-Jun	24.8	23.0	21.7
18-May	19.8	19.2	18.3		30-Jun	25.6	23.8	22.5

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #7 at a depth 2.0 meters, June 6 through September 1, 2002 (continued).**

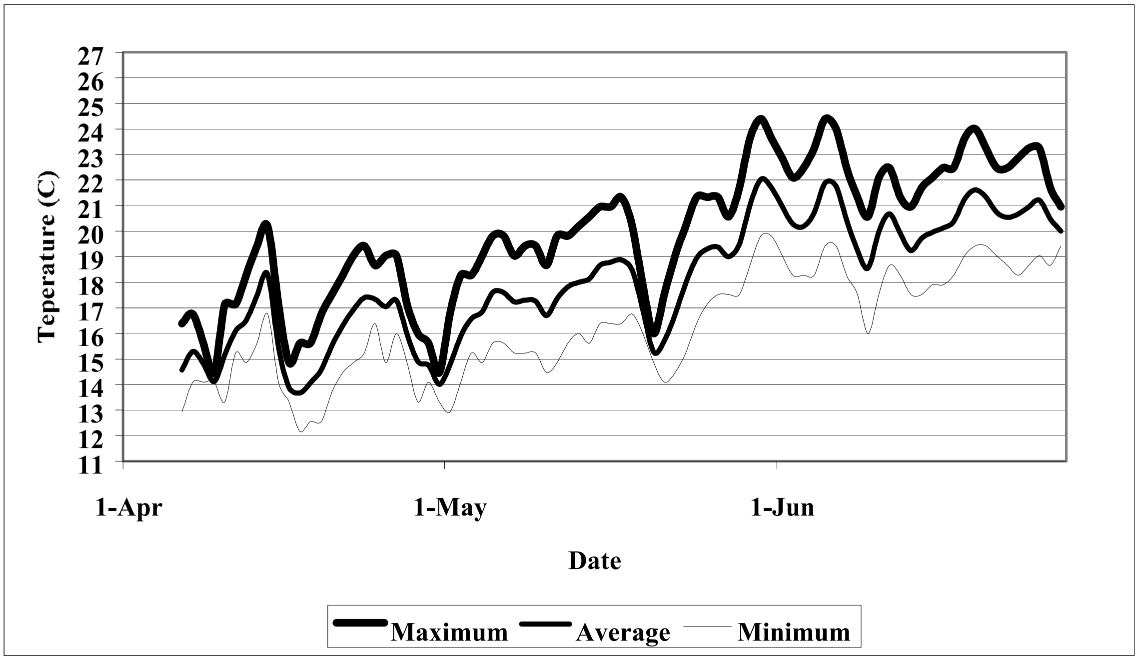
Date	Maximum	Average	Minimum		Date	Maximum	Average	Minimum
1-Jul	26.0	24.2	22.9		13-Aug	22.9	21.2	20.2
2-Jul	25.6	23.9	22.5		14-Aug	22.9	21.1	20.2
3-Jul	24.8	23.0	22.1		15-Aug	22.5	20.9	20.2
4-Jul	24.4	22.7	21.3		16-Aug	22.1	20.6	19.8
5-Jul	24.8	22.7	21.3		17-Aug	21.7	20.2	19.4
6-Jul	24.4	22.7	21.3		18-Aug	21.3	20.0	19.0
7-Jul	25.2	23.0	21.7		19-Aug	21.0	19.7	19.0
8-Jul	25.2	23.1	21.7		20-Aug	21.0	19.7	19.0
9-Jul	25.6	23.5	22.1		21-Aug	21.3	19.9	19.0
10-Jul	26.7	24.3	22.5		22-Aug	21.0	19.7	19.0
11-Jul	26.7	24.3	22.5		23-Aug	20.2	19.0	18.3
12-Jul	25.6	24.0	22.9		24-Aug	20.2	19.0	18.3
13-Jul	25.2	23.4	22.1		25-Aug	21.0	19.3	18.3
14-Jul	24.8	22.9	21.7		26-Aug	21.7	20.0	18.7
15-Jul	24.0	22.3	21.3		27-Aug	22.9	20.8	19.0
16-Jul	23.2	21.6	20.6		28-Aug	22.9	21.0	19.8
17-Jul	22.9	21.3	20.2		29-Aug	21.0	20.1	19.0
18-Jul	23.6	21.6	20.2		30-Aug	21.0	19.5	18.7
19-Jul	24.0	22.0	20.6		31-Aug	21.3	19.6	18.7
20-Jul	24.8	22.6	21.0		1-Sep	22.1	20.3	19.0
21-Jul	22.5	21.7	20.2		2-Sep	22.9	20.8	19.4
22-Jul	22.5	20.8	19.8		3-Sep	22.5	20.6	19.4
23-Jul	22.9	21.0	19.8		4-Sep	21.7	20.1	19.4
24-Jul	22.9	21.1	19.8		5-Sep	21.0	19.4	18.3
25-Jul	23.2	21.3	20.2		6-Sep	20.2	18.7	17.5
26-Jul	23.6	21.5	20.2		7-Sep	20.2	18.4	17.1
27-Jul	23.6	21.7	20.6		8-Sep	20.2	18.4	17.1
28-Jul	22.5	21.3	20.2		9-Sep	19.8	18.2	17.1
29-Jul	22.9	21.0	19.8		10-Sep	21.0	19.4	17.9
30-Jul	23.2	21.2	20.2		11-Sep	20.6	19.2	17.9
31-Jul	23.2	21.3	20.2		12-Sep	20.6	19.1	17.9
1-Aug	23.6	21.4	20.2		13-Sep	20.2	18.8	17.9
2-Aug	23.2	21.5	20.6		14-Sep	19.8	18.7	17.9
3-Aug	21.3	20.6	19.4		15-Sep	19.4	18.5	17.9
4-Aug	21.0	19.7	18.7		16-Sep	19.4	18.3	17.5
5-Aug	22.1	20.1	18.7		17-Sep	20.2	18.9	17.5
6-Aug	22.5	20.3	18.7		18-Sep	21.3	19.6	18.3
7-Aug	22.9	20.6	19.0		19-Sep	21.3	19.8	18.7
8-Aug	23.2	21.1	19.4		20-Sep	21.3	19.6	18.3
9-Aug	24.0	21.7	19.8		21-Sep	21.0	19.4	18.3
10-Aug	24.4	22.2	20.6		22-Sep	21.0	19.2	17.9
11-Aug	24.0	22.0	20.6		23-Sep	20.6	19.1	17.9
12-Aug	23.6	21.5	20.2		24-Sep	20.6	18.9	17.5

Appendix B. **Daily maximum, average, and minimum water temperatures recorded at Station #7 at a depth 2.0 meters, June 6 through September 1, 2002 (concluded).**

Date	Maximum	Average	Minimum
25-Sep	20.2	18.6	17.5
26-Sep	19.4	18.2	17.5
27-Sep	18.3	17.6	17.1
28-Sep	17.5	16.7	16.0
29-Sep	17.9	16.5	15.2
30-Sep	17.9	16.7	15.6
1-Oct	17.9	16.6	15.6
2-Oct	17.5	16.2	15.2
3-Oct	17.1	15.9	14.9
4-Oct	17.5	16.0	14.9
5-Oct	18.3	16.7	15.6
6-Oct	19.0	17.4	16.0
7-Oct	19.4	17.8	16.4
8-Oct	19.0	17.8	16.8
9-Oct	19.0	17.6	16.4
10-Oct	17.9	17.1	16.8
11-Oct	17.5	16.7	16.0
12-Oct	17.5	16.5	15.6
13-Oct	17.1	16.1	15.2
14-Oct	17.1	15.9	15.2
15-Oct	16.4	15.7	15.2
16-Oct	16.0	15.5	15.2
17-Oct	15.6	14.9	14.5
18-Oct	15.6	14.7	14.1
19-Oct	16.0	15.2	14.5
20-Oct	16.8	15.8	15.2
21-Oct	16.8	15.9	15.2
22-Oct	16.0	15.5	15.2

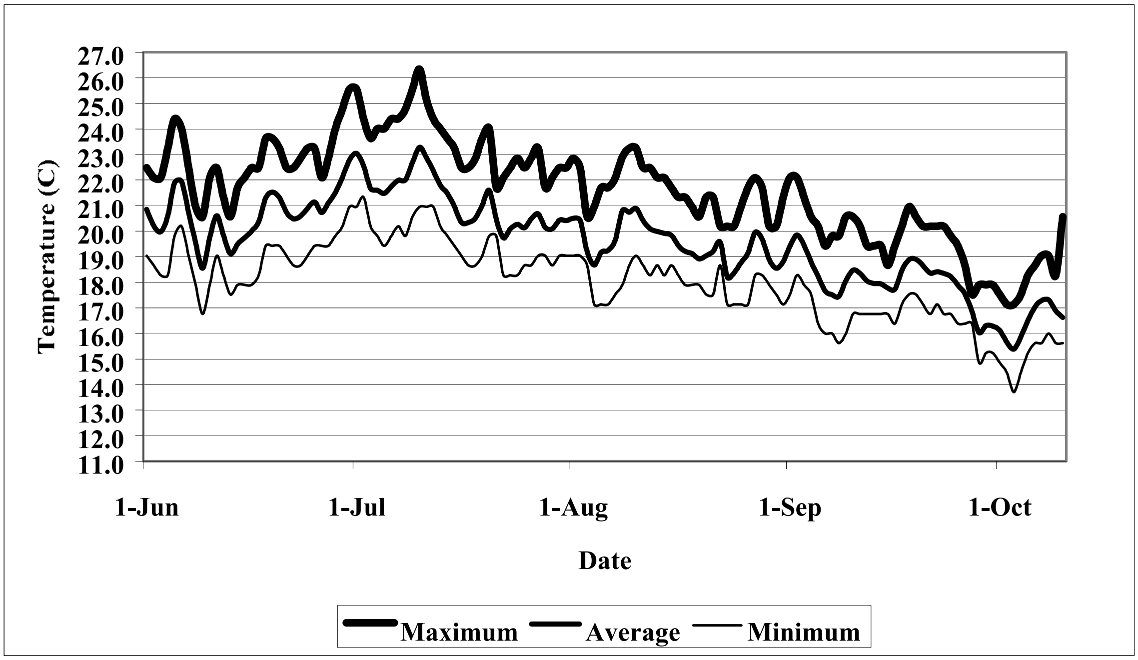
APPENDIX C

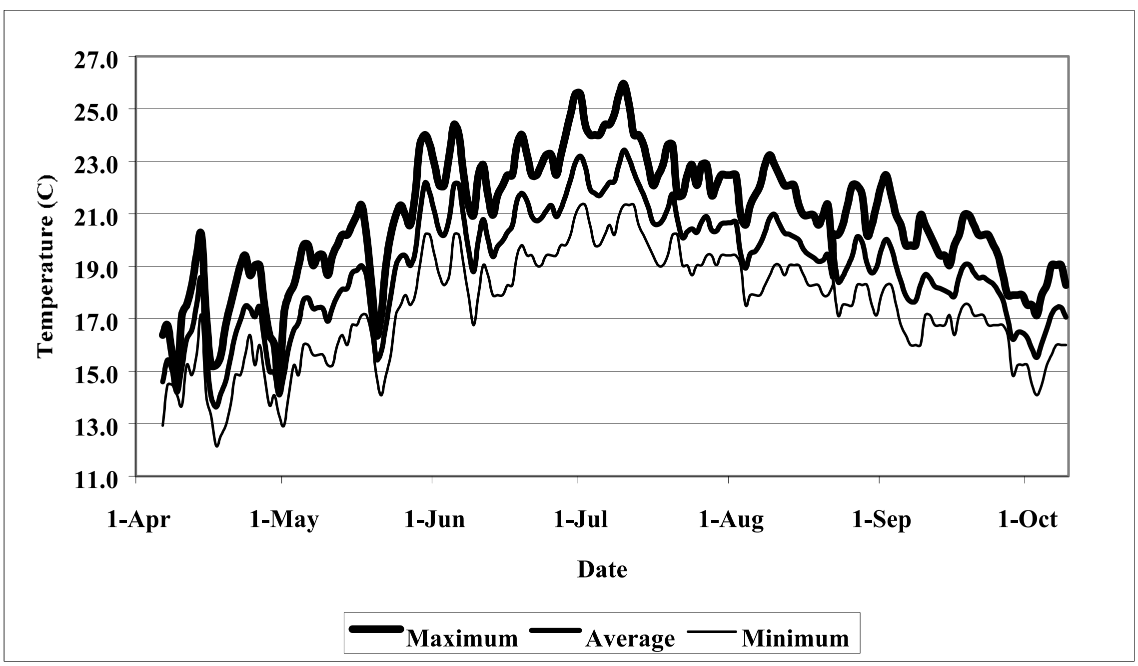
GRAPHS OF DAILY MAXIMUM, AVERAGE, AND MINIMUM WATER TEMPERATURES RECORDED NEAR THE RIVER'S SURFACE AND THE DEEPEST POINT AT EACH SAMPLING STATION WITHIN THE MIRABEL STUDYAREA, 2002 SAMPLING SEASON.



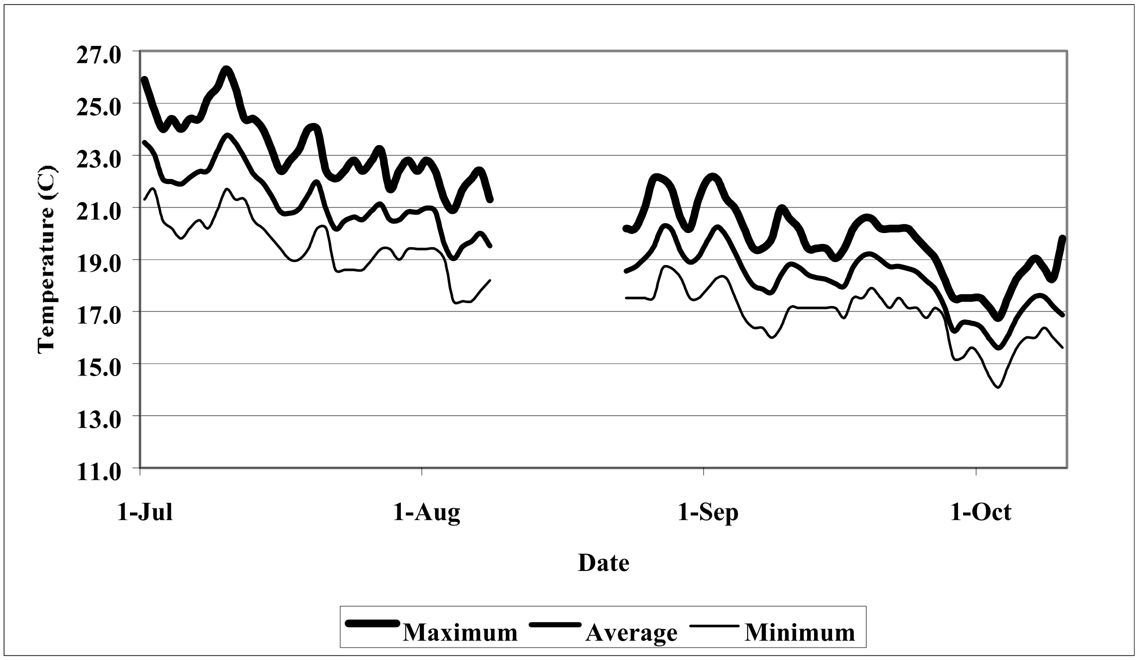
The surface data logger failed at Station #1

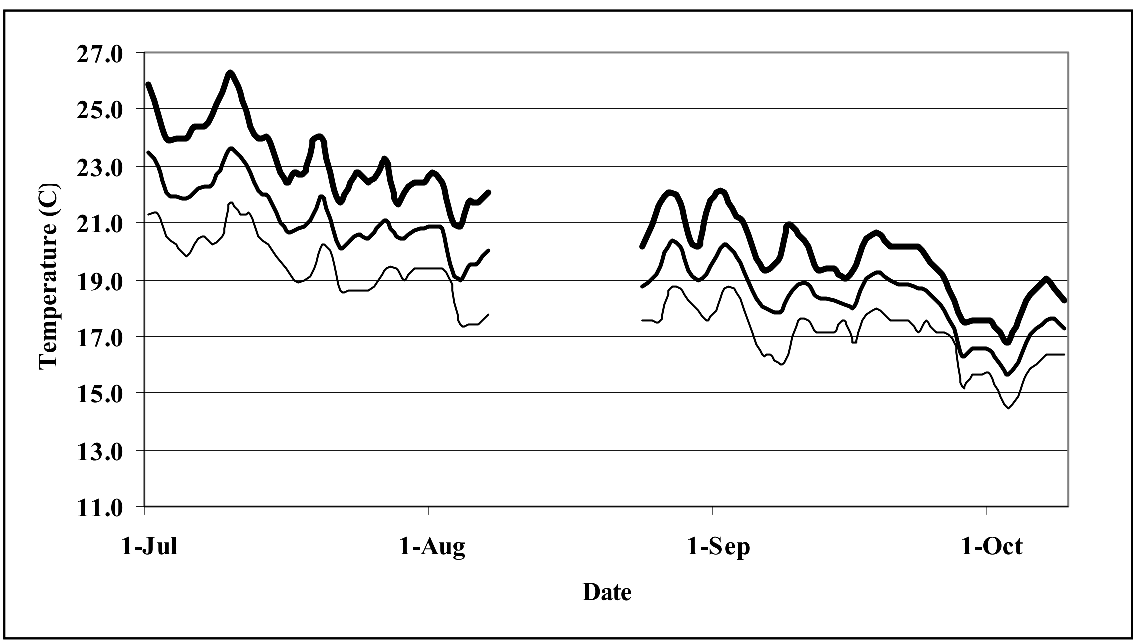
Appendix C. Graph of maximum, average, and minimum water temperatures, Station #1, 0.5 meters (top) and 2.0 meters (bottom), 2002.



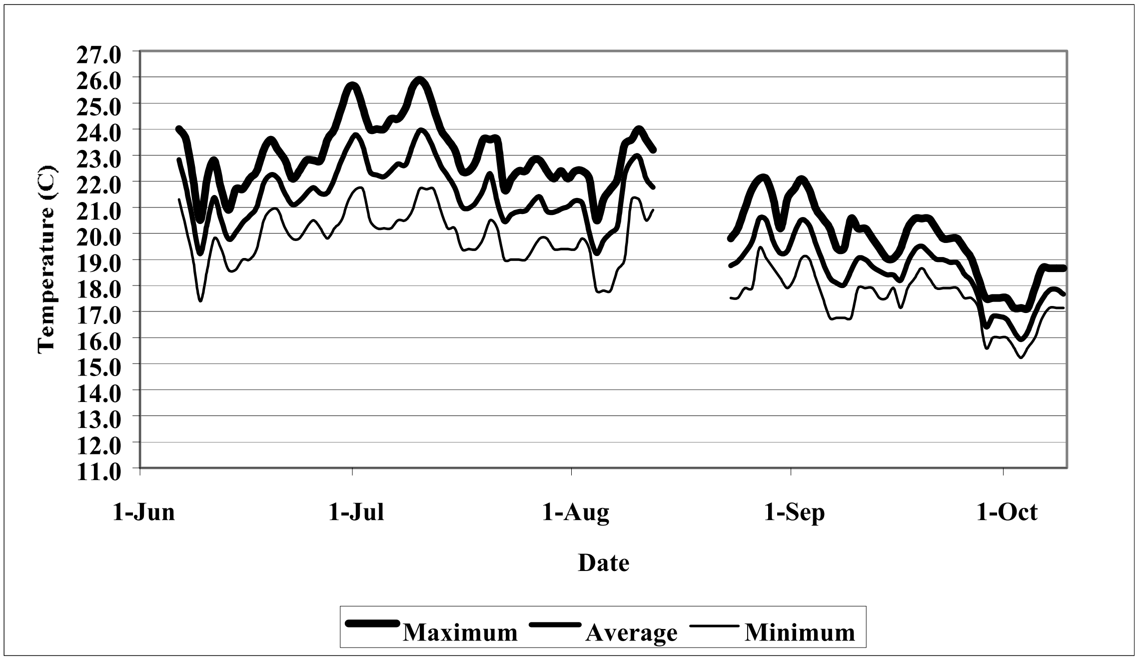


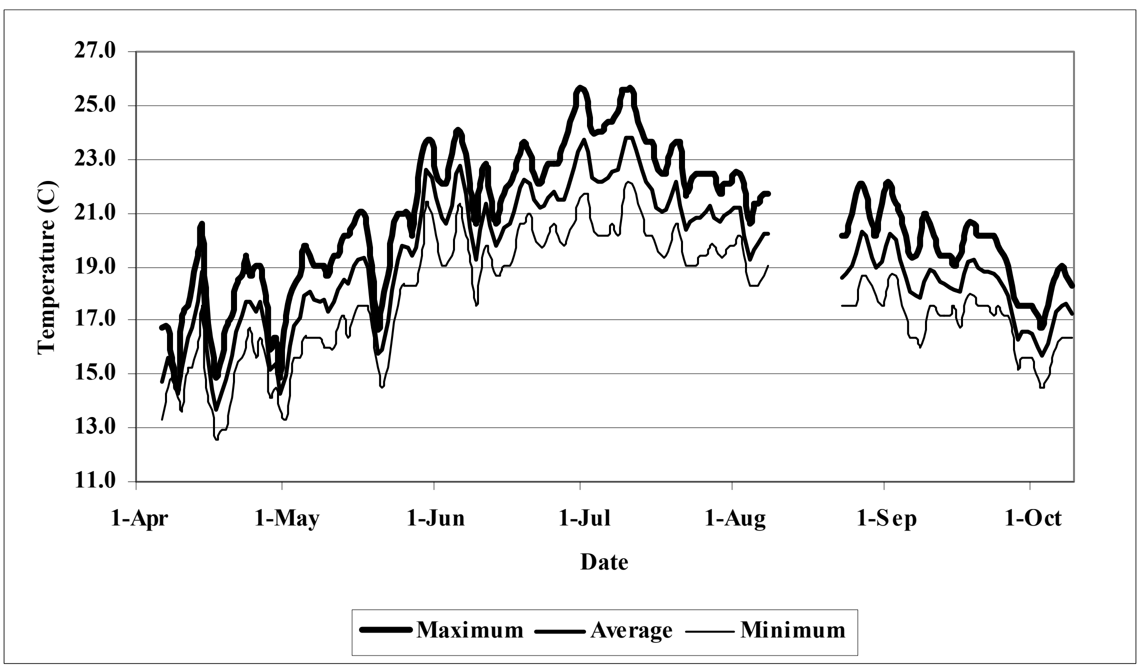
Appendix C. **Graph of maximum, average, and minimum water temperatures, Station #2, 0.5 meters (top) and 3.0 meters (bottom), 2002.**



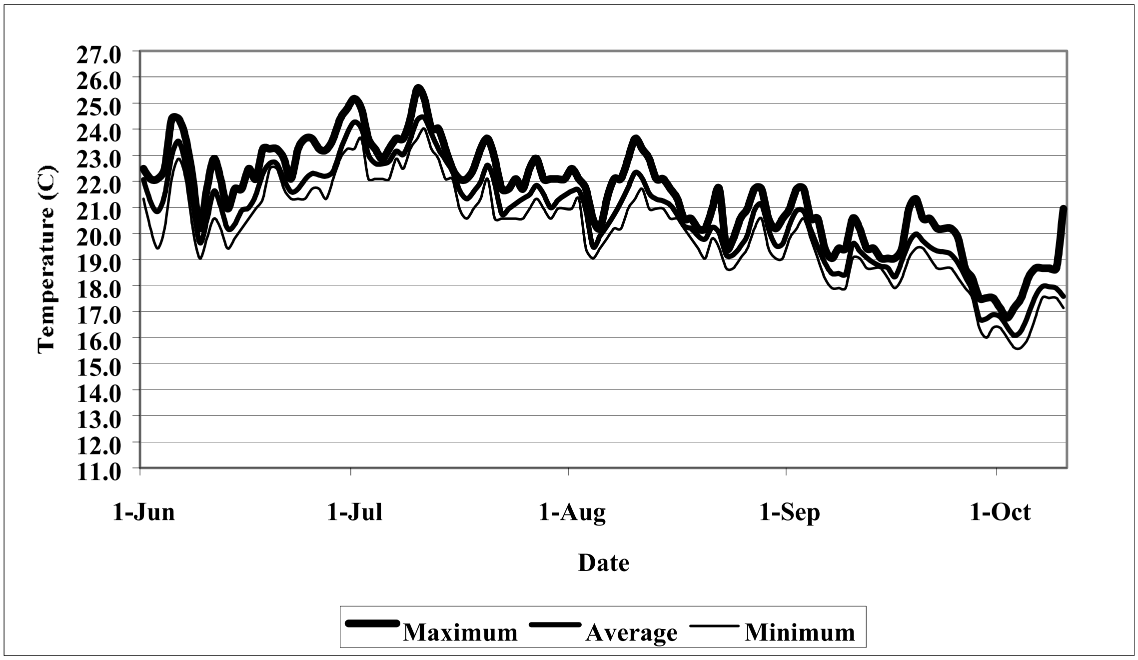


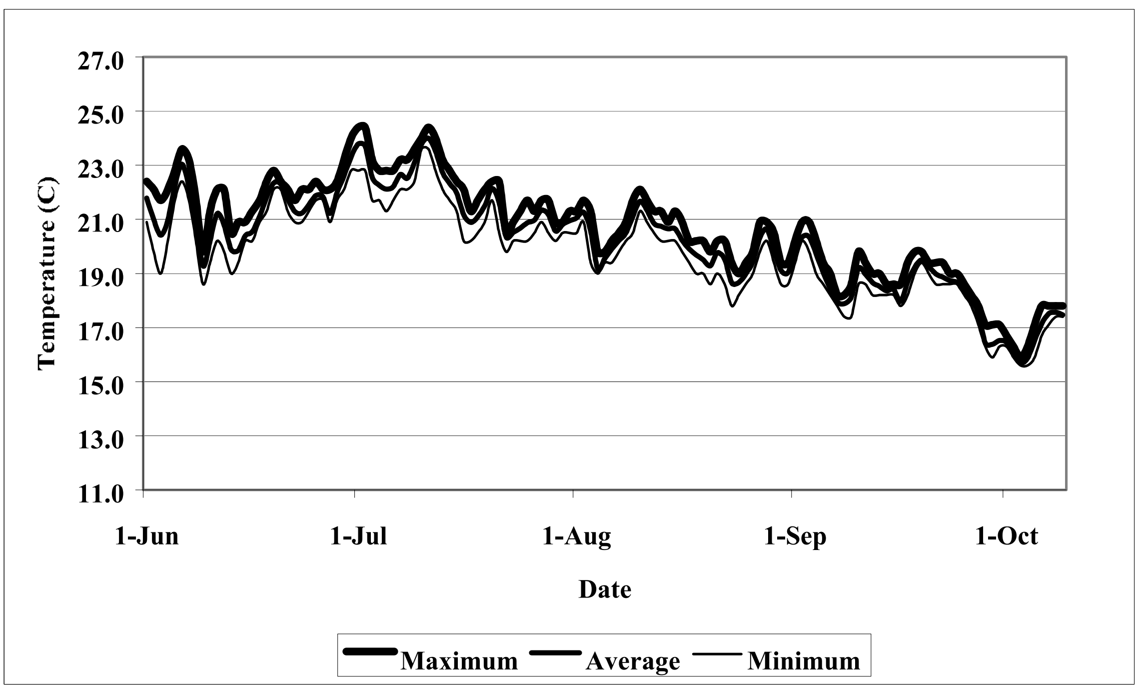
Appendix C. **Graph of maximum, average, and minimum water temperatures, Station #3, 0.5 meters (top) and 4.0 meters (bottom), 2002.**



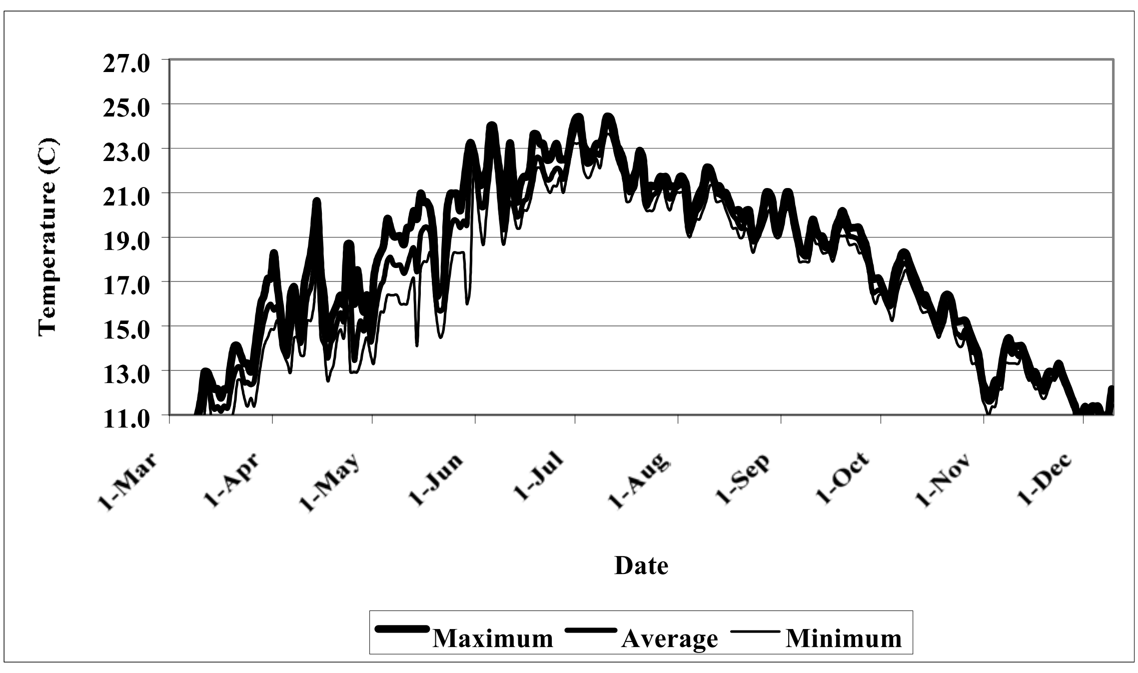


Appendix C. **Graph of maximum, average, and minimum water temperatures, Station #4, 0.5 meters (top) and 3.0 meters (bottom), 2002.**

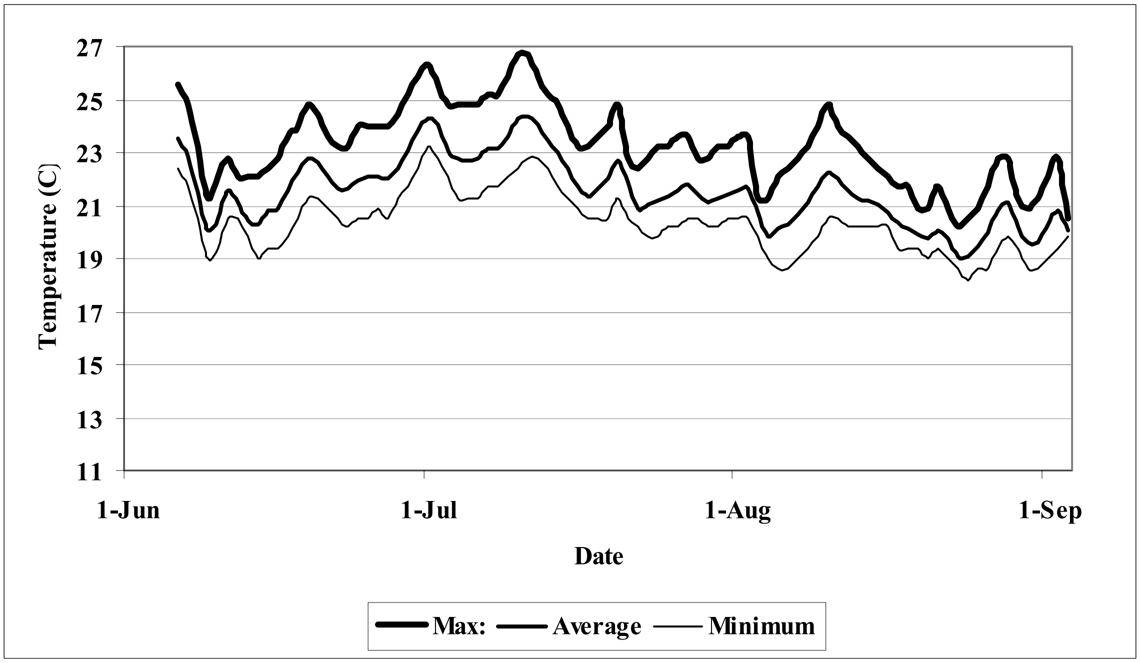


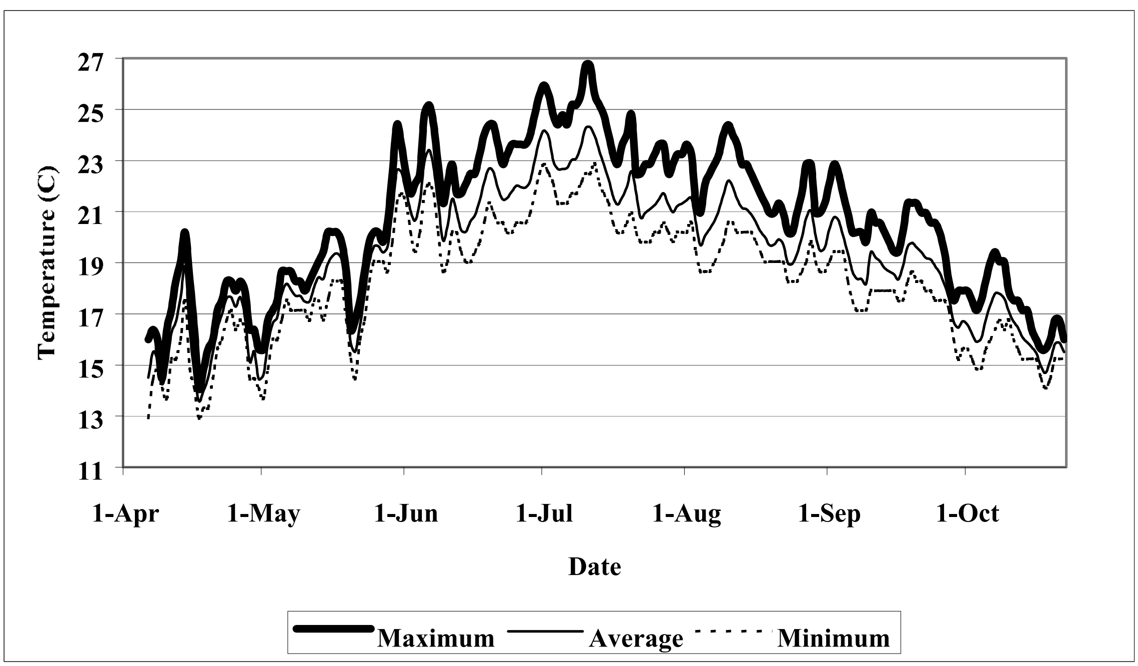


Appendix C. **Graph of maximum, average, and minimum water temperatures, Station #5, 0.5 meters (top) and 3.0 meters (bottom), 2002.**



Appendix C. **Graph of maximum, average, and minimum water temperatures, Station #6, 1.0 meters, 2002.**





Appendix C. **Graph of maximum, average, and minimum water temperatures, Station #7, 0.5 meters (top) and 2.0 meters (bottom), 2002.**

APPENDIX D

NUMBER AND PERCENTAGE OF DAYS THAT THE VARIOUS WATER TEMPERATURE CRITERIA WERE EXCEEDED, BY MONTH, FOR EACH OF THE SEVEN WATER TEMPERATURE STATIONS, 2002

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #2, recorded at a depth of 0.5 meters, June 1 through September 30, 2002.**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	>16.7	>17.8	>20.0	>21.1	>23.0		>16.3	>18.0	>20.0	>22.0	24.0	>25.0	> 26.0
June	30	30	30	25	10	0		30	30	30	25	6	0	0
July	31	31	31	29	12	0		31	31	31	29	10	3	0
August	31	31	31	6	0	0		31	31	31	7	0	0	0
September	30	30	21	0	0	0		30	25	11	0	0	0	0
Total	**122**	**122**	**113**	**60**	**22**	**0**		**122**	**117**	**103**	**61**	**16**	**3**	**0**

	>14.5	>16.7	>17.8	>20.0	>21.1	>23.0		>16.3	>18.0	>20.0	>22.0	24.0	>25.0	> 26.0
June	100.0	100.0	100.0	83.3	33.3	0.0		100.0	100.0	100.0	83.3	20.0	0.0	0.0
July	100.0	100.0	100.0	93.5	38.7	0.0		100.0	100.0	100.0	93.5	32.3	9.7	0.0
August	100.0	100.0	100.0	19.4	0.0	0.0		100.0	100.0	100.0	22.6	0.0	0.0	0.0
September	100.0	100.0	70.0	0.0	0.0	0.0		100.0	83.3	36.7	0.0	0.0	0.0	0.0
Total	**100.0**	**100.0**	**92.6**	**49.2**	**18.0**	**0.0**		**100.0**	**95.9**	**84.4**	**50.0**	**13.1**	**2.5**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #2, recorded at a depth of 2.0 meters, April 6 through September 30, 2002.**

Month	**Weekly Average Temperature**							**Weekly Maximum Temperature**				**Daily Maximum**		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
April	25	3	0	0	0	0		25	6	0	0	0	0	0
May	31	31	17	7	3	0		31	31	15	3	0	0	0
June	30	30	30	27	5	0		30	30	30	27	6	0	0
July	31	31	31	30	15	0		31	31	31	28	10	0	0
August	31	31	31	8	0	0		31	31	31	7	0	0	0
September	30	26	22	0	0	0		30	26	15	0	0	0	0
Total	**178**	**152**	**131**	**72**	**23**	**0**		**178**	**155**	**122**	**65**	**16**	**0**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
April	83.3	10.0	0.0	0.0	0.0	0.0		83.3	20.0	0.0	0.0	0.0	0.0	0.0
May	100.0	100.0	54.8	22.6	9.7	0.0		100.0	100.0	48.4	9.7	0.0	0.0	0.0
June	100.0	100.0	100.0	90.0	16.7	0.0		100.0	100.0	100.0	90.0	20.0	0.0	0.0
July	100.0	100.0	100.0	96.8	48.4	0.0		100.0	100.0	100.0	90.3	32.3	0.0	0.0
August	100.0	100.0	100.0	25.8	0.0	0.0		100.0	100.0	100.0	22.6	0.0	0.0	0.0
September	100.0	86.7	73.3	0.0	0.0	0.0		100.0	86.7	50.0	0.0	0.0	0.0	0.0
Total	**100.0**	**85.4**	**73.6**	**40.4**	**12.9**	**0.0**		**100.0**	**87.1**	**68.5**	**36.5**	**9.0**	**0.0**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #3, recorded at a depth of 0.5 meters, July 1 through September 30, 2002 (excluding data lost between August 9 and August 22).**

Month	**Weekly Average Temperature**							**Weekly Maximum Temperature**				**Daily Maximum**		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	N/A							N/A						
July	31	31	31	31	17	0		31	31	31	30	10	4	0
August	11	11	11	0	0	0		11	11	11	0	0	0	0
September	30	26	22	0	0	0		30	25	13	0	0	0	0
Total	**72**	**68**	**64**	**31**	**17**	**0**		**72**	**67**	**55**	**30**	**10**	**4**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	N/A							N/A						
July	100.0	100.0	100.0	100.0	54.8	0.0		100.0	100.0	100.0	96.8	32.3	12.9	0.0
August	100.0	100.0	100.0	0.0	0.0	0.0		100.0	100.0	100.0	0.0	0.0	0.0	0.0
September	100.0	86.7	73.3	0.0	0.0	0.0		100.0	83.3	43.3	0.0	0.0	0.0	0.0
Total	**100.0**	**94.4**	**88.9**	**43.1**	**23.6**	**0.0**		**100.0**	**93.1**	**76.4**	**41.7**	**13.9**	**5.6**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #3, recorded at a depth of 4.0 meters, July 1 through September30, 2002.**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
July	31	31	31	31	10	0		31	31	31	30	10	4	0
August	9	9	9	0	0	0		9	9	9	0	0	0	0
September	30	26	22	0	0	0		30	25	13	0	0	0	0
Total	**70**	**66**	**62**	**31**	**10**	**0**		**70**	**65**	**53**	**30**	**10**	**4**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
July	100.0	100.0	100.0	100.0	32.3	0.0		100.0	100.0	100.0	96.8	32.3	12.9	0.0
August	29.0	29.0	29.0	0.0	0.0	0.0		29.0	29.0	29.0	0.0	0.0	0.0	0.0
September	100.0	86.7	73.3	0.0	0.0	0.0		100.0	83.3	43.3	0.0	0.0	0.0	0.0
Total	**100.0**	**94.3**	**88.6**	**44.3**	**14.3**	**0.0**		**100.0**	**92.9**	**75.7**	**42.9**	**14.3**	**5.7**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #4, recorded at a depth of 0.5 meters, June 6 through September 30, 2002 (Excluding data lost between August 13 and August 22).**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	25	25	25	25	17	0		25	25	25	21	6	0	0
July	31	31	31	31	26	5		31	31	31	29	10	3	0
August	21	21	21	12	3	0		21	21	21	9	3	1	0
September	30	26	23	0	0	0		30	25	11	0	0	0	0
Total	**107**	**103**	**100**	**68**	**46**	**5**		**107**	**102**	**88**	**59**	**19**	**4**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	83.3	83.3	83.3	83.3	56.7	0.0		83.3	83.3	83.3	70.0	20.0	0.0	0.0
July	100.0	100.0	100.0	100.0	83.9	16.1		100.0	100.0	100.0	93.5	32.3	9.7	0.0
August	100.0	100.0	100.0	57.1	14.3	0.0		67.7	67.7	67.7	29.0	9.7	3.2	0.0
September	100.0	86.7	76.7	0.0	0.0	0.0		100.0	83.3	36.7	0.0	0.0	0.0	0.0
Total	**100.0**	**96.3**	**93.5**	**63.6**	**43.0**	**4.7**		**100.0**	**95.3**	**82.2**	**55.1**	**17.8**	**3.7**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #4, recorded at a depth of 3.0 meters, April 6 through September 30, 2002 (Excluding data lost between August 9 and August 22).**

Month	**Weekly Average Temperature**							**Weekly Maximum Temperature**				**Daily Maximum**		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
April	25	5	0	0	0	0		25	7	0	0	0	0	0
May	31	31	23	8	0	0		31	31	13	7	0	0	0
June	30	30	30	30	7	0		30	30	30	24	6	0	0
July	31	31	31	31	22	4		31	31	31	28	10	2	0
August	11	11	11	2	0	0		11	11	11	0	0	0	0
September	30	26	22	0	0	0		25	25	13	0	0	0	0
Total	**158**	**134**	**117**	**71**	**29**	**4**		**153**	**135**	**98**	**59**	**16**	**2**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
April	83.3	16.7	0.0	0.0	0.0	0.0		83.3	23.3	0.0	0.0	0.0	0.0	0.0
May	100.0	100.0	74.2	25.8	0.0	0.0		100.0	100.0	41.9	22.6	0.0	0.0	0.0
June	100.0	100.0	100.0	100.0	23.3	0.0		100.0	100.0	100.0	80.0	20.0	0.0	0.0
July	100.0	100.0	100.0	100.0	71.0	12.9		100.0	100.0	100.0	90.3	32.3	6.5	0.0
August	35.5	35.5	35.5	6.5	0.0	0.0		35.5	35.5	35.5	0.0	0.0	0.0	0.0
September	100.0	86.7	73.3	0.0	0.0	0.0		83.3	83.3	43.3	0.0	0.0	0.0	0.0
Total	**100.0**	**84.8**	**74.1**	**44.9**	**18.4**	**2.5**		**96.8**	**85.4**	**62.0**	**37.3**	**10.1**	**1.3**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #5, recorded at a depth of 0.5 meters, June 1 through September 30, 2002.**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	30	30	30	30	26	5		30	30	30	26	6	0	0
July	31	31	31	31	29	10		31	31	31	28	5	0	0
August	31	31	31	27	7	0		31	31	31	7	0	0	0
September	30	28	24	0	0	0		30	25	9	0	0	0	0
Total	**122**	**120**	**116**	**88**	**62**	**15**		**122**	**117**	**101**	**61**	**11**	**0**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	100.0	100.0	100.0	100.0	86.7	16.7		100.0	100.0	100.0	86.7	20.0	0.0	0.0
July	100.0	100.0	100.0	100.0	93.5	32.3		100.0	100.0	100.0	90.3	16.1	0.0	0.0
August	100.0	100.0	100.0	87.1	22.6	0.0		100.0	100.0	100.0	22.6	0.0	0.0	0.0
September	100.0	93.3	80.0	0.0	0.0	0.0		100.0	83.3	30.0	0.0	0.0	0.0	0.0
Total	**100.0**	**98.4**	**95.1**	**72.1**	**50.8**	**12.3**		**100.0**	**95.9**	**82.8**	**50.0**	**9.0**	**0.0**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #5, recorded at a depth of 3.0 meters, June 1 through September 30, 2002.**

Month	**Weekly Average Temperature**							**Weekly Maximum Temperature**				**Daily Maximum**		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	30	30	30	30	30	13		30	30	30	30	7	0	0
July	31	31	31	31	31	12		31	31	31	21	11	0	0
August	31	31	31	27	11	0		31	31	31	7	0	0	0
September	30	28	26	3	0	0		30	26	4	0	0	0	0
Total	**122**	**120**	**118**	**91**	**72**	**25**		**122**	**118**	**96**	**58**	**18**	**0**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	100.0	100.0	100.0	100.0	100.0	43.3		100.0	100.0	100.0	100.0	23.3	0.0	0.0
July	100.0	100.0	100.0	87.1	35.5	0.0		100.0	100.0	100.0	22.6	0.0	0.0	0.0
August	96.8	90.3	83.9	9.7	0.0	0.0		96.8	83.9	12.9	0.0	0.0	0.0	0.0
September	100.0	93.3	86.7	10.0	0.0	0.0		100.0	86.7	13.3	0.0	0.0	0.0	0.0
Total	**100.0**	**98.4**	**96.7**	**74.6**	**59.0**	**20.5**		**100.0**	**96.7**	**78.7**	**47.5**	**14.8**	**0.0**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #6, recorded at a depth of 1.5 meters, March 9 through November 30, 2002.**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
March	6	0	0	0	0	0		3	0	0	0	0	0	0
April	24	0	0	0	0	0		16	1	0	0	0	0	0
May	24	15	10	4	0	0		19	12	5	3	0	0	0
June	30	30	30	30	24	3		30	30	30	24	0	0	0
July	31	31	31	31	28	5		31	31	31	15	0	0	0
August	31	31	31	16	5	0		31	31	27	0	0	0	0
September	31	26	23	0	0	0		30	24	0	0	0	0	0
October	23	7	0	0	0	0		9	0	0	0	0	0	0
November	0	0	0	0	0	0		0	0	0	0	0	0	0
Total	**146**	**125**	**115**	**77**	**57**	**8**		**131**	**116**	**88**	**39**	**0**	**0**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
March	26.1	0.0	0.0	0.0	0.0	0.0		13.0	0.0	0.0	0.0	0.0	0.0	0.0
April	80.0	0.0	0.0	0.0	0.0	0.0		53.3	3.3	0.0	0.0	0.0	0.0	0.0
May	77.4	48.4	32.3	12.9	0.0	0.0		61.3	38.7	16.1	9.7	0.0	0.0	0.0
June	100.0	100.0	100.0	100.0	80.0	10.0		100.0	100.0	100.0	80.0	0.0	0.0	0.0
July	100.0	100.0	100.0	100.0	90.3	16.1		100.0	100.0	100.0	48.4	0.0	0.0	0.0
August	100.0	100.0	100.0	51.6	16.1	0.0		100.0	100.0	87.1	0.0	0.0	0.0	0.0
September	103.3	86.7	76.7	0.0	0.0	0.0		100.0	80.0	0.0	0.0	0.0	0.0	0.0
October	74.2	22.6	0.0	0.0	0.0	0.0		29.0	0.0	0.0	0.0	0.0	0.0	0.0
November	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**54.7**	**46.8**	**43.1**	**28.8**	**21.3**	**3.0**		**49.1**	**43.4**	**33.0**	**14.6**	**0.0**	**0.0**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #7, recorded at a depth of 0.5 meters, June 6 through August 31, 2002.**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	25	25	25	25	22	5		25	25	25	25	8	5	0
July	31	31	31	31	29	10		31	31	31	31	13	10	0
August	31	31	31	25	7	0		31	31	31	6	0	0	0
September	N/A							25	25	25	25	8	5	0
Total	**87**	**87**	**87**	**81**	**58**	**15**		**87**	**87**	**87**	**62**	**21**	**15**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
June	100.0	100.0	100.0	100.0	88.0	20.0		100.0	100.0	100.0	100.0	32.0	20.0	0.0
July	100.0	100.0	100.0	100.0	93.5	32.3		100.0	100.0	100.0	100.0	41.9	32.3	0.0
August	100.0	100.0	100.0	80.6	22.6	0.0		100.0	100.0	100.0	19.4	0.0	0.0	0.0
September	N/A													
Total	**100.0**	**100.0**	**100.0**	**93.1**	**66.7**	**17.2**		**100.0**	**100.0**	**100.0**	**71.3**	**24.1**	**17.2**	**0.0**

Appendix D. **Number and percentage of days that the various water temperature criteria were exceeded, by month, at Station #7, recorded at a depth of 2.0 meters, April 6 through October 16, 2002.**

Month	Weekly Average Temperature							Weekly Maximum Temperature				Daily Maximum		
	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
April	25	4	0	0	0	0		22	1	0	0	0	0	0
May	31	31	22	8	6	0		31	30	9	5	0	0	0
June	30	30	30	30	25	5		30	30	30	30	7	3	0
July	31	31	31	31	29	10		31	31	31	31	13	8	0
August	31	31	31	22	7	0		31	31	31	14	0	0	0
September	30	28	23	0	0	0		30	26	21	0	0	0	0
Total	**122**	**120**	**115**	**83**	**61**	**15**		**122**	**118**	**113**	**75**	**20**	**11**	**0**

	>14.5	**>16.7**	**>17.8**	**>20.0**	**>21.1**	**>23.0**		**>16.3**	**>18.0**	**>20.0**	**>22.0**	**24.0**	**>25.0**	**> 26.0**
April	83.3	13.3	0.0	0.0	0.0	0.0		73.3	3.3	0.0	0.0	0.0	0.0	0.0
May	100.0	100.0	71.0	25.8	19.4	0.0		100.0	96.8	29.0	16.1	0.0	0.0	0.0
June	100.0	100.0	100.0	100.0	83.3	16.7		100.0	100.0	100.0	100.0	23.3	10.0	0.0
July	100.0	100.0	100.0	100.0	93.5	32.3		100.0	100.0	100.0	100.0	41.9	25.8	0.0
August	100.0	100.0	100.0	71.0	22.6	0.0		100.0	100.0	100.0	45.2	0.0	0.0	0.0
September	100.0	93.3	76.7	0.0	0.0	0.0		100.0	86.7	70.0	0.0	0.0	0.0	0.0
Total	**100.0**	**98.4**	**94.3**	**68.0**	**50.0**	**12.3**		**100.0**	**96.7**	**92.6**	**61.5**	**16.4**	**9.0**	**0.0**

APPENDIX E

DAILY CATCH IN ROTARY SCREW TRAPS, MIRABEL STUDY AREA, RUSSIAN RIVER, MARCH 1 THROUGH JUNE 27, 2002

Appendix E. Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27.

Date	Chinook smolts	Hatchery steelhead	Wild steelhead	Steelhead parr	YOY steelhead	Adult Pacific lamprey	Eyed Pacific lamprey	Lamprey ammocoetes	Western Brook lamprey
1-Mar	3	4	0	0	0	0	0	19	0
2-Mar	10	1	0	0	0	0	0	28	0
3-Mar	17	4	1	0	0	0	0	14	0
4-Mar	15	0	0	0	0	0	0	3	0
5-Mar	7	19	0	0	0	0	0	10	0
6-Mar	4	8	0	0	0	0	0	0	0
7-Mar	9	16	0	0	0	0	0	6	0
8-Mar	19	3	0	0	0	0	2	29	0
9-Mar	20	3	1	0	0	1	0	7	0
10-Mar	7	1	0	0	0	0	0	23	0
11-Mar	8	0	0	0	0	0	0	22	0
12-Mar	22	1	1	0	0	0	0	18	0
13-Mar	36	36	0	0	0	0	0	4	0
14-Mar	69	47	0	0	1	0	0	10	0
15-Mar	34	147	12	0	0	1	0	0	0
16-Mar	46	294	4	0	0	2	0	9	0
17-Mar	33	209	12	0	0	0	0	10	0
18-Mar	79	142	9	0	0	0	0	29	0
19-Mar	64	174	5	1	1	0	0	16	1
20-Mar	38	109	3	0	2	2	0	19	0
21-Mar	32	69	2	0	1	0	0	11	0
22-Mar	21	25	0	1	0	0	0	10	0
23-Mar	6	20	2	0	0	0	0	40	0
24-Mar	2	11	0	0	1	0	0	93	0
25-Mar	18	1	2	0	1	0	0	27	0
26-Mar	89	3	4	0	0	0	0	12	0
27-Mar	230	4	0	0	0	2	0	10	0
28-Mar	189	10	1	0	1	0	1	2	0
29-Mar	131	4	4	0	0	0	0	0	0
30-Mar	25	0	0	0	0	0	0	0	0
31-Mar	58	3	4	0	2	0	0	8	0
1-Apr	75	1	11	0	0	0	0	21	0
2-Apr	115	5	4	0	5	0	0	12	0
3-Apr	121	2	7	0	5	1	0	20	0
4-Apr	69	4	4	0	14	0	0	7	0
5-Apr	120	2	4	1	4	0	0	3	0
6-Apr	191	2	2	0	6	2	0	5	0
7-Apr	175	4	5	1	6	1	0	18	0
8-Apr	117	1	4	0	15	1	0	20	0
9-Apr	82	8	5	0	6	1	0	7	0
10-Apr	159	4	3	0	6	0	0	7	0
11-Apr	64	12	4	0	3	0	0	5	1
12-Apr	97	138	15	0	6	1	0	4	0
13-Apr	108	64	3	0	8	1	0	8	0
14-Apr	107	41	2	0	5	1	0	4	0

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27 (continued).**

Date	Chinook smolts	Hatchery steelhead	Wild steelhead	Steelhead parr	YOY steelhead	Adult Pacific lamprey	Eyed Pacific lamprey	Lamprey ammocoetes	Western Brook lamprey
15-Apr	140	29	1	0	17	0	0	19	0
16-Apr	Not sampled, dam went up								
17-Apr	584	11	2	0	160	1	0	56	0
18-Apr	482	32	12	2	79	1	0	9	0
19-Apr	345	8	2	0	81	2	0	22	0
20-Apr	295	7	3	**0**	46	0	0	6	0
21-Apr	155	6	6	**0**	42	1	0	0	0
22-Apr	418	8	5	0	39	0	0	1	0
23-Apr	519	4	2	0	36	0	0	2	0
24-Apr	234	7	1	0	13	1	0	11	0
25-Apr	578	12	5	0	6	1	0	4	0
26-Apr	270	7	3	0	3	1	0	0	1
27-Apr	375	4	4	0	2	0	0	0	1
28-Apr	585	4	4	0	9	0	0	0	0
29-Apr	431	3	4	0	12	0	0	3	0
30-Apr	645	1	5	1	21	0	0	1	0
1-May	652	2	4	0	90	1	1	3	0
2-May	1011	4	3	0	96	2	0	1	0
3-May	465	2	1	0	105	0	0	2	0
4-May	387	1	2	0	81	0	0	0	0
5-May	587	1	6	0	132	0	0	0	0
6-May	590	2	2	0	132	1	1	1	0
7-May	429	1	0	1	79	0	0	1	0
8-May	176	1	2	0	85	0	0	5	0
9-May	185	0	0	0	78	0	0	5	0
10-May	203	0	1	0	127	0	0	2	0
11-May	306	0	0	0	152	0	0	0	0
12-May	215	0	3	1	94	0	0	0	0
13-May	266	0	1	0	140	0	0	5	0
14-May	464	1	2	0	94	0	0	11	0
15-May	432	1	2	0	180	0	0	18	0
16-May	214	0	2	0	189	0	0	6	0
17-May	263	1	1	0	114	0	0	5	0
18-May	383	2	0	0	189	0	0	4	0
19-May	210	0	1	0	94	0	0	0	0
20-May	90	0	1	0	116	0	0	0	0
21-May	34	0	0	0	172	0	1	0	0
22-May	224	1	3	0	386	0	0	1	0
23-May	276	2	1	0	311	0	0	0	0
24-May	455	0	0	0	150	0	0	0	0
25-May	358	1	2	0	206	0	0	0	0
26-May	171	1	1	0	37	0	0	1	0
27-May	237	0	2	0	53	0	0	4	0
28-May	127	0	0	0	55	0	0	4	0
29-May	134	1	0	0	58	0	0	0	0

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27 (continued).**

Date	Chinook smolts	Hatchery steelhead	Wild steelhead	Steelhead parr	YOY steelhead	Adult Pacific lamprey	Eyed Pacific lamprey	Lamprey ammocoetes	Western Brook lamprey
30-May	139	0	0	0	105	0	0	0	0
31-May	97	0	1	0	303	0	0	3	0
1-Jun	85	1	0	0	86	0	0	2	0
2-Jun	67	0	0	0	83	0	0	2	0
3-Jun	55	0	1	0	116	0	1	0	0
4-Jun	49	0	0	0	107	0	0	0	0
5-Jun	48	0	0	0	65	0	1	0	0
6-Jun	34	0	0	0	96	0	0	1	0
7-Jun	16	0	0	0	41	0	0	3	0
8-Jun	18	0	0	0	55	0	0	4	0
9-Jun	9	0	0	0	41	0	0	0	0
10-Jun	18	0	0	1	61	0	1	1	0
11-Jun	31	0	0	0	36	0	0	1	0
12-Jun	7	0	0	0	31	0	0	2	0
13-Jun	8	0	0	0	12	0	0	2	0
14-Jun	7	0	1	0	9	0	0	1	0
15-Jun	10	0	1	0	21	0	0	0	0
16-Jun	10	0	1	0	27	0	0	0	0
17-Jun	20	0	0	0	28	0	0	0	0
18-Jun	4	0	0	0	21	0	0	0	0
19-Jun	9	0	1	0	6	0	0	0	0
20-Jun	15	0	0	0	11	0	0	0	0
21-Jun	3	0	0	0	8	0	0	0	0
22-Jun	0	0	1	0	4	0	0	0	0
23-Jun	8	0	0	0	6	0	0	0	0
24-Jun	7	0	0	0	3	0	0	0	0
25-Jun	4	0	0	0	0	0	0	0	0
26-Jun	0	0	0	0	0	0	0	0	0
27-Jun	0	0	0	0	1	0	0	0	0
TOTALS	**19,319**	**1,825**	**249**	**10**	**5,843**	**29**	**9**	**865**	**4**

Appendix E. Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).

Date	White catfish	Bullhead	Largemouth bass	Smallmouth bass	Green sunfish	Bluegill	White crappie	Pikeminnow	Hardhead
1-Mar	0	0	0	0	0	0	0	0	0
2-Mar	0	0	0	0	0	0	0	0	0
3-Mar	0	0	0	0	0	0	0	1	0
4-Mar	0	0	0	0	0	0	0	0	0
5-Mar	0	0	0	0	0	0	1	0	0
6-Mar	0	0	0	0	0	0	0	0	0
7-Mar	0	0	0	0	0	0	0	0	0
8-Mar	0	0	0	0	0	1	0	0	0
9-Mar	0	0	0	0	0	0	0	1	0
10-Mar	0	0	0	0	0	0	0	0	0
11-Mar	0	0	0	0	0	1	0	1	0
12-Mar	0	0	0	0	0	3	0	1	0
13-Mar	0	0	0	0	0	1	1	1	2
14-Mar	0	0	0	0	0	0	1	1	1
15-Mar	0	0	0	0	0	0	0	1	1
16-Mar	0	0	0	0	0	0	0	1	0
17-Mar	0	0	0	0	0	0	0	0	0
18-Mar	0	0	0	0	0	0	0	0	1
19-Mar	0	0	0	0	0	0	0	0	0
20-Mar	0	0	0	0	0	0	0	0	1
21-Mar	0	0	0	0	0	0	0	2	1
22-Mar	0	1	0	0	0	0	0	1	1
23-Mar	0	0	0	0	0	0	0	1	0
24-Mar	1	0	1	0	0	0	0	1	0
25-Mar	0	0	0	0	0	3	0	0	2
26-Mar	0	0	0	0	0	4	0	2	2
27-Mar	1	0	0	0	0	7	0	4	1
28-Mar	0	0	0	0	0	0	0	2	1
29-Mar	0	0	0	0	0	1	0	2	0
30-Mar	0	0	0	0	3	0	0	1	0
31-Mar	0	0	0	0	0	0	0	2	0
1-Apr	0	3	0	0	0	0	0	2	2
2-Apr	0	1	0	0	1	1	0	0	0
3-Apr	0	1	0	1	0	2	0	6	0
4-Apr	0	0	0	0	0	1	0	0	1
5-Apr	1	0	0	0	0	1	0	1	1
6-Apr	0	0	0	0	0	0	0	3	2
7-Apr	0	0	0	0	0	0	0	2	0
8-Apr	1	0	0	0	0	0	0	1	1
9-Apr	0	0	0	0	0	0	0	0	1
10-Apr	0	0	0	0	0	0	0	0	3
11-Apr	0	0	0	0	0	0	0	0	1
12-Apr	0	0	0	0	1	0	0	0	1
13-Apr	0	2	0	0	0	0	0	2	0
14-Apr	0	1	0	0	0	0	0	0	0
15-Apr	1	1	0	0	1	0	0	0	0

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).**

Date	White catfish	Bullhead	Largemouth bass	Smallmouth bass	Green sunfish	Bluegill	White crappie	Pikeminnow	Hardhead
16-Apr									
17-Apr	1	0	0	1	0	1	0	0	0
18-Apr	0	0	0	0	0	0	0	0	0
19-Apr	1	0	0	0	0	1	1	0	1
20-Apr	0	0	0	0	0	1	0	0	0
21-Apr	0	0	0	0	0	0	0	0	0
22-Apr	0	0	0	0	0	2	0	0	1
23-Apr	1	0	0	0	0	2	0	3	0
24-Apr	1	0	0	0	0	0	1	0	1
25-Apr	0	1	0	0	0	0	0	0	1
26-Apr	0	0	0	0	2	1	0	2	2
27-Apr	1	0	0	0	2	0	0	0	2
28-Apr	0	0	0	0	0	0	0	0	0
29-Apr	0	0	0	0	0	0	0	0	1
30-Apr	0	0	0	0	0	1	0	0	0
1-May	0	0	0	0	0	3	0	0	0
2-May	0	0	0	0	3	0	0	1	0
3-May	0	0	0	0	0	1	0	0	0
4-May	1	0	0	0	0	0	0	0	1
5-May	2	0	0	0	0	0	0	0	1
6-May	2	0	0	0	0	1	0	0	1
7-May	0	0	0	0	0	1	0	0	3
8-May	2	0	0	0	2	1	0	0	4
9-May	0	1	0	0	0	0	0	0	2
10-May	0	0	0	0	0	0	0	1	0
11-May	0	0	0	0	0	0	0	0	0
12-May	0	2	0	0	0	0	0	0	0
13-May	2	0	0	0	0	0	0	0	1
14-May	0	0	0	0	1	2	0	1	1
15-May	0	0	0	0	1	3	0	2	1
16-May	0	1	0	0	1	0	0	1	0
17-May	0	0	0	0	2	1	0	0	0
18-May	2	0	0	0	0	1	1	3	0
19-May	0	0	0	0	1	0	0	0	0
20-May	0	0	0	0	0	1	0	0	0
21-May	0	0	0	1	0	0	0	0	0
22-May	0	0	0	0	0	1	0	1	0
23-May	0	0	0	2	1	0	1	2	2
24-May	3	0	0	2	1	5	0	2	0
25-May	3	0	0	0	0	3	1	2	0
26-May	4	0	0	1	0	0	2	0	0
27-May	4	0	0	2	2	2	2	0	0
28-May	2	0	0	0	0	2	1	0	0
29-May	2	0	0	0	1	0	0	1	0
30-May	1	0	0	0	0	0	0	0	0
31-May	1	0	0	1	1	2	0	0	0

Appendix E. Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).

Date	White catfish	Bullhead	Largemouth bass	Smallmouth bass	Green sunfish	Bluegill	White crappie	Pikeminnow	Hardhead
1-Jun	1	0	0	3	1	0	0	0	0
2-Jun	1	0	0	2	0	0	1	0	0
3-Jun	1	0	0	0	0	0	0	0	0
4-Jun	0	0	0	6	0	1	0	0	0
5-Jun	5	0	0	1	0	1	0	0	0
6-Jun	5	0	0	3	0	2	0	0	0
7-Jun	0	0	0	1	0	1	0	0	0
8-Jun	2	0	0	0	0	0	0	0	0
9-Jun	0	0	0	1	0	0	0	1	0
10-Jun	0	0	0	4	0	1	0	0	0
11-Jun	0	0	0	3	0	0	0	0	0
12-Jun	0	0	0	2	0	0	0	0	0
13-Jun	1	0	0	0	0	0	0	0	0
14-Jun	0	0	0	0	0	0	0	3	0
15-Jun	0	0	0	4	0	0	0	1	0
16-Jun	0	0	0	4	0	0	0	1	0
17-Jun	0	2	0	12	0	0	0	0	0
18-Jun	0	0	0	4	0	0	0	0	0
19-Jun	2	0	0	2	0	0	0	0	0
20-Jun	0	0	0	5	0	0	0	0	0
21-Jun	1	0	0	4	0	0	0	0	0
22-Jun	2	0	0	2	0	1	0	0	0
23-Jun	2	0	0	3	0	0	0	0	0
24-Jun	0	0	0	5	0	0	0	0	0
25-Jun	0	0	0	1	0	0	0	0	0
26-Jun	1	0	0	3	0	1	0	0	0
27-Jun	0	0	0	6	0	0	0	0	0
Total	**65**	**17**	**1**	**92**	**28**	**73**	**14**	**71**	**53**

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).**

Date	Sculpin	Tule perch	Threespine stickleback	Sacramento sucker	Golden shiner	Hitch	Carp
1-Mar	0	0	1	0	0	0	0
2-Mar	0	0	0	0	0	0	0
3-Mar	0	0	0	1	0	0	0
4-Mar	1	0	0	0	0	0	0
5-Mar	0	0	0	0	0	0	0
6-Mar	0	0	0	0	0	0	0
7-Mar	2	0	1	2	0	0	0
8-Mar	5	0	0	0	0	0	0
9-Mar	3	0	0	0	0	0	0
10-Mar	3	0	0	0	0	0	0
11-Mar	1	0	0	1	0	0	0
12-Mar	1	0	0	0	1	0	0
13-Mar	0	0	1	1	1	0	0
14-Mar	0	0	0	1	1	0	0
15-Mar	0	0	0	1	0	0	0
16-Mar	1	0	0	1	0	0	0
17-Mar	0	0	0	0	0	0	0
18-Mar	1	0	1	0	0	0	0
19-Mar	0	0	0	0	0	0	0
20-Mar	1	0	0	1	0	0	0
21-Mar	0	0	0	1	0	0	0
22-Mar	0	0	0	1	0	0	0
23-Mar	2	0	0	9	0	0	0
24-Mar	2	0	0	1	0	0	0
25-Mar	0	0	0	2	0	0	0
26-Mar	1	0	0	5	1	0	0
27-Mar	0	0	0	1	0	0	0
28-Mar	2	0	0	4	0	0	0
29-Mar	0	0	1	3	0	0	0
30-Mar	1	0	1	0	0	0	0
31-Mar	0	0	0	1	0	0	0
1-Apr	0	0	1	1	0	0	0
2-Apr	0	0	0	3	0	0	0
3-Apr	0	0	1	1	0	0	0
4-Apr	0	0	0	2	0	1	0
5-Apr	0	0	0	1	0	0	0
6-Apr	0	1	0	0	0	0	0
7-Apr	1	1	0	3	0	0	0
8-Apr	0	0	1	1	0	0	0
9-Apr	0	0	1	1	0	0	0
10-Apr	0	0	1	1	0	0	0
11-Apr	0	0	2	0	0	1	0
12-Apr	0	0	5	2	0	0	0
13-Apr	0	0	36	0	0	0	0
14-Apr	0	0	78	2	0	0	0
15-Apr	1	1	96	4	0	0	0

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).**

Date	Sculpin	Tule perch	Threespine stickleback	Sacramento sucker	Golden shiner	Hitch	Carp
16-Apr							
17-Apr	2	0	6	2	0	0	0
18-Apr	2	0	48	2	0	0	0
19-Apr	7	0	78	4	0	0	0
20-Apr	3	0	156	10	0	1	0
21-Apr	5	0	235	1	0	0	0
22-Apr	4	0	401	2	0	0	0
23-Apr	9	0	167	1	0	1	0
24-Apr	7	0	189	0	0	0	0
25-Apr	13	0	74	0	0	0	0
26-Apr	1	0	75	0	0	0	0
27-Apr	6	1	110	0	0	0	0
28-Apr	3	1	77	2	0	0	0
29-Apr	4	0	104	0	0	0	0
30-Apr	3	0	169	1	0	0	0
1-May	11	0	38	0	0	0	0
2-May	7	0	149	1	0	0	0
3-May	1	1	87	2	0	0	0
4-May	6	0	204	3	0	0	0
5-May	3	2	414	3	0	0	0
6-May	3	0	327	4	0	0	0
7-May	2	0	150	0	0	0	0
8-May	1	0	88	1	0	0	0
9-May	4	0	108	1	0	0	0
10-May	1	0	101	0	0	0	0
11-May	1	0	46	1	0	0	0
12-May	0	0	95	1	0	0	0
13-May	1	0	91	0	0	0	0
14-May	0	1	11	2	0	0	0
15-May	2	0	69	4	0	0	0
16-May	2	0	38	2	0	0	0
17-May	0	0	23	1	0	0	0
18-May	1	0	10	0	0	0	0
19-May	0	0	15	1	0	0	0
20-May	0	0	1	0	0	0	0
21-May	1	0	6	1	0	0	0
22-May	0	0	1	7	0	0	0
23-May	1	0	27	4	1	0	0
24-May	2	0	46	2	0	0	0
25-May	1	0	0	0	0	0	0
26-May	2	0	10	0	0	0	0
27-May	1	0	8	0	0	0	0
28-May	0	0	9	0	0	0	0
29-May	2	1	3	0	0	0	0
30-May	0	0	1	1	0	0	1
31-May	1	0	3	0	0	0	1

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).**

Date	Sculpin	Tule perch	Threespine stickleback	Sacramento sucker	Golden shiner	Hitch	Carp
1-Jun	2	0	2	0	0	0	3
2-Jun	3	0	4	0	0	0	9
3-Jun	0	1	0	0	0	0	0
4-Jun	0	2	0	0	0	0	0
5-Jun	2	0	0	0	0	0	2
6-Jun	0	0	2	0	0	0	2
7-Jun	5	0	2	0	0	0	2
8-Jun	1	0	0	0	0	0	2
9-Jun	3	1	1	0	0	0	11
10-Jun	2	1	0	0	0	0	5
11-Jun	4	2	2	0	0	0	5
12-Jun	3	1	0	0	0	0	4
13-Jun	3	1	0	0	0	0	4
14-Jun	0	1	0	0	0	0	3
15-Jun	1	1	0	0	0	0	0
16-Jun	2	0	0	0	0	0	8
17-Jun	0	2	0	0	0	0	3
18-Jun	2	1	1	0	0	0	1
19-Jun	0	0	0	0	0	0	0
20-Jun	3	2	0	0	0	0	2
21-Jun	0	0	0	0	0	0	6
22-Jun	1	1	0	0	0	0	5
23-Jun	0	0	0	0	0	0	5
24-Jun	0	1	0	0	0	0	9
25-Jun	0	0	0	0	0	0	1
26-Jun	0	1	0	0	0	0	2
27-Jun	0	0	0	0	0	0	4
TOTALS	**192**	**29**	**4,310**	**126**	**5**	**4**	**100**

Appendix E. Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).

Date	Blackfish	Roach	Fathead minnow	Larval Cyprinid	Larval suckers
1-Mar	0	0	0	0	0
2-Mar	0	0	0	0	0
3-Mar	0	0	0	0	0
4-Mar	0	0	0	0	0
5-Mar	0	0	0	0	0
6-Mar	0	0	0	0	0
7-Mar	0	0	0	0	0
8-Mar	0	0	0	0	0
9-Mar	0	0	0	0	0
10-Mar	0	0	0	0	0
11-Mar	0	0	0	0	0
12-Mar	0	0	0	0	0
13-Mar	0	0	0	0	0
14-Mar	0	0	0	0	0
15-Mar	0	0	0	0	0
16-Mar	0	0	0	0	0
17-Mar	0	0	0	0	0
18-Mar	0	0	0	0	0
19-Mar	0	0	0	0	0
20-Mar	0	0	0	0	0
21-Mar	0	0	0	0	0
22-Mar	0	0	0	0	0
23-Mar	0	0	0	0	0
24-Mar	0	0	0	0	0
25-Mar	0	0	0	0	0
26-Mar	0	0	0	0	0
27-Mar	0	0	0	0	0
28-Mar	0	0	0	0	0
29-Mar	0	1	0	0	0
30-Mar	0	0	0	0	0
31-Mar	0	0	1	0	0
1-Apr	0	0	0	0	0
2-Apr	0	0	0	0	0
3-Apr	0	0	0	0	0
4-Apr	0	0	0	0	0
5-Apr	0	0	0	0	0
6-Apr	0	0	0	0	0
7-Apr	1	1	0	0	0
8-Apr	0	0	0	0	0
9-Apr	0	0	0	0	0
10-Apr	0	1	0	0	0
11-Apr	0	0	0	0	0
12-Apr	0	0	0	0	0
13-Apr	0	0	0	0	0
14-Apr	0	0	0	0	0
15-Apr	0	1	0	0	0

Appendix E. **Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).**

Date	Blackfish	Roach	Fathead minnow	Larval Cyprinid	Larval suckers
16-Apr					
17-Apr	2	0	0	0	0
18-Apr	0	0	0	0	0
19-Apr	1	0	0	0	0
20-Apr	0	0	0	0	0
21-Apr	0	0	0	0	0
22-Apr	0	0	0	0	0
23-Apr	0	0	0	0	0
24-Apr	0	0	0	0	0
25-Apr	0	1	0	0	0
26-Apr	0	1	0	0	10's
27-Apr	0	0	0	0	10's
28-Apr	0	0	0	0	10's
29-Apr	0	0	0	0	10's
30-Apr	0	0	0	0	ca. 100
1-May	0	1	0	0	10's
2-May	0	2	0	0	10's
3-May	2	0	0	0	low 100's
4-May	0	0	0	0	low 100's
5-May	0	2	0	0	high 100's
6-May	0	2	0	0	high 100's
7-May	0	1	0	0	low 1,000's
8-May	0	0	0	0	low 1,000's
9-May	0	0	0	0	low 1,000's
10-May	0	2	0	0	low 1,000's
11-May	0	0	0	0	low 1,000's
12-May	0	1	0	0	low 1,000's
13-May	0	0	0	0	low 1,000's
14-May	1	0	0	0	high 1000's
15-May	0	0	0	0	Low 1000's
16-May	0	0	0	0	Low 1000's
17-May	0	0	0	0	Low 1000's
18-May	0	2	0	0	Low 1000's
19-May	0	0	0	0	Low 100's
20-May	0	0	0	0	Low 100's
21-May	0	0	0	0	Mid 100's
22-May	0	0	0	0	low 100's
23-May	0	3	0	0	Low 1000's
24-May	0	1	0	0	Low 1000's
25-May	0	2	0	0	low 100's
26-May	0	0	0	0	low 100's
27-May	0	1	0	0	low 100's
28-May	0	0	0	0	high 100's
29-May	0	2	0	0	low 100's
30-May	0	0	0	0	Low 1000's
31-May	0	0	0	0	Low 1000's

Appendix E. Daily catch in rotary screw traps, Mirabel Study Area, Russian River, March 1 through June 27, 2002 (continued).

Date	Blackfish	Roach	Fathead minnow	Larval Cyprinid	Larval suckers
1-Jun	0	0	0	0	Low 1000's
2-Jun	0	0	0	0	Low 100's
3-Jun	0	0	0	very few	Low 1000's
4-Jun	0	1	0	0	Low 1000's
5-Jun	0	0	0	very few	Low 1000's
6-Jun	0	0	0	0	low 100's
7-Jun	0	0	0	0	low 100's
8-Jun	0	1	0	0	low 100's
9-Jun	0	0	0	0	low 100's
10-Jun	0	0	0	0	High 10's
11-Jun	0	0	0	0	low 100's
12-Jun	0	0	0	0	High 10's
13-Jun	0	0	0	0	high 100's
14-Jun	0	0	0	0	low 100's
15-Jun	0	1	0	0	low 100's
16-Jun	0	0	0	Low #'s	low 10's
17-Jun	0	0	0	Low #'s	low 100's
18-Jun	0	0	0	Low #'s	low 10's
19-Jun	0	0	0	Low #'s	low 10's
20-Jun	0	0	0	Low #'s	high 10's
21-Jun	1	1	0	Low #'s	low 10's
22-Jun	0	1	0	Low #'s	low 10's
23-Jun	0	1	0	Low #'s	low 10's
24-Jun	0	0	0	Low #'s	low 10's
25-Jun	0	1	0	Low #'s	low 10's
26-Jun	0	0	0	Low #'s	low 10's
27-Jun	0	0	0	Low #'s	low 100's
TOTALS	**8**	**35**	**1**		

APPENDIX F

NUMBER OF FISH CAUGHT AND CATCH-PER-UNIT-EFFORT, BY STATION, MIRABEL STUDY AREA, RUSSIAN RIVER, AUGUST 2001

Appendix F. Number of fish caught and catch-per-unit-effort in Reach #1 shoreline sampling stations, Mirabel Study Area, August 2002.

	NUMBER CAUGHT						CATCH-PER-UNIT-EFFORT				
							Minutes sampled				
							11.07	7.57	10.65	8.50	37.79
Species	Station 1	Station 2	Station 4	Station 5	Totals		Station 1	Station 2	Station 4	Station 5	Totals
Wild steelhead	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Chinook	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Pikeminnow	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Hardhead	12	3	0	5	**20**		1.08	0.40	0.00	0.59	**0.53**
Roach	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Blackfish	7	2	5	0	**14**		0.63	0.26	0.47	0.00	**0.37**
Hitch	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Tule perch	17	7	3	5	**32**		1.54	0.92	0.28	0.59	**0.85**
Sucker	19	43	36	45	**143**		1.72	5.68	3.38	5.29	**3.78**
Sculpin	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Stickleback	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Hatchery steelhead	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
Smallmouth bass	16	15	15	23	**69**		1.45	1.98	1.41	2.71	**1.83**
Largemouth bass	6	1	0	0	**7**		0.54	0.13	0.00	0.00	**0.19**
Bluegill	4	5	2	15	**26**		0.36	0.66	0.19	1.76	**0.69**
Green sunfish	8	8	3	11	**30**		0.72	1.06	0.28	1.29	**0.79**
Redear sunfish	2	0	0	0	**2**		0.18	0.00	0.00	0.00	**0.05**
Crappie	2	0	0	1	**3**		0.18	0.00	0.00	0.12	**0.08**
American shad	0	2	0	0	**2**		0.00	0.26	0.00	0.00	**0.05**
Carp	4	0	8	0	**12**		0.36	0.00	0.75	0.00	**0.32**
Bullhead	0	0	1	0	**1**		0.00	0.00	0.09	0.00	**0.03**
White catfish	1	0	0	0	**1**		0.09	0.00	0.00	0.00	**0.03**
Striped bass	0	0	0	0	**0**		0.00	0.00	0.00	0.00	**0.00**
TOTAL	**98**	**86**	**73**	**105**	**362**		**8.85**	**11.36**	**6.85**	**12.35**	**9.58**

Appendix F. Number of fish caught and catch-per-unit-effort in Reach #1 mid channel sampling stations, Mirabel Study Area, August 2002.

	NUMBER CAUGHT		CATCH-PER-UNIT-EFFORT
			Minutes sampled
			7.57
Species	**Station 5**		**Station 5**
Wild steelhead	0		0.00
Chinook	1		0.13
Pikeminnow	1		0.13
Hardhead	1		0.13
Roach	0		0.00
Blackfish	1		0.13
Hitch	0		0.00
Tule perch	3		0.40
Sucker	24		3.17
Sculpin	0		0.00
Stickleback	0		0.00
Hatchery steelhead	0		0.00
Smallmouth bass	5		0.66
Largemouth bass	0		0.00
Bluegill	0		0.00
Green sunfish	0		0.00
Redear sunfish	0		0.00
Crappie	0		0.00
American shad	0		0.00
Carp	0		0.00
Bullhead	0		0.00
White catfish	0		0.00
Striped bass	0		0.00
TOTAL	**36**		**4.76**

Appendix F. **Number of fish caught and catch-per-unit-effort in Reach #2 shoreline sampling stations, Mirabel Study Area, August 2002.**

	NUMBER CAUGHT							CATCH-PER-UNIT-EFFORT						
								Minutes sampled						
								8.83	**7.62**	**8.85**	**8.90**	**9.58**	**8.90**	**52.68**
Species	**Station 1**	**Station 2**	**Station 4**	**Station 5**	**Station 7**	**Station 8**	**Totals**	**Station 1**	**Station 2**	**Station 4**	**Station 5**	**Station 7**	**Station 8**	**Totals**
Wild steelhead	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Chinook	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Pikeminnow	4	0	1	4	2	6	**17**	0.45	0.00	0.11	0.45	0.21	0.67	**0.32**
Hardhead	15	11	21	43	16	28	**134**	1.70	1.44	2.37	4.83	1.67	3.15	**2.54**
Roach	0	0	0	2	1	1	**4**	0.00	0.00	0.00	0.22	0.10	0.11	**0.08**
Blackfish	0	0	0	1	0	0	**1**	0.00	0.00	0.00	0.11	0.00	0.00	**0.02**
Hitch	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Tule perch	1	4	0	11	13	34	**63**	0.11	0.52	0.00	1.24	1.36	3.82	**1.20**
Sucker	3	4	5	7	8	11	**38**	0.34	0.52	0.56	0.79	0.84	1.24	**0.72**
Sculpin	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Stickleback	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Hatchery steelhead	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Smallmouth bass	8	13	30	25	23	38	**137**	0.91	1.71	3.39	2.81	2.40	4.27	**2.60**
Largemouth bass	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Bluegill	1	0	0	0	1	0	**2**	0.11	0.00	0.00	0.00	0.10	0.00	**0.04**
Green sunfish	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Redear sunfish	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Crappie	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
American shad	0	1	0	0	0	0	**1**	0.00	0.13	0.00	0.00	0.00	0.00	**0.02**
Carp	3	1	1	0	0	4	**9**	0.34	0.13	0.11	0.00	0.00	0.45	**0.17**
Bullhead	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
White catfish	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Striped bass	0	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
TOTAL	**35**	**34**	**58**	**93**	**64**	**122**	**406**	**3.96**	**4.46**	**6.55**	**10.45**	**6.68**	**13.71**	**7.71**

Appendix F. Number of fish caught and catch-per-unit-effort in Reach #2 mid channel sampling stations, Mirabel Study Area, August 2002.

	NUMBER CAUGHT					CATCH-PER-UNIT-EFFORT			
						Minutes sampled			
						12.93	13.50	18.22	52.68
Species	Station 3	Station 6	Station 9	Totals		Station 3	Station 6	Station 9	Totals
Wild steelhead	0	0	0	0		0.00	0.00	0.00	0.00
Chinook	0	0	0	0		0.00	0.00	0.00	0.00
Pikeminnow	1	0	0	1		0.08	0.00	0.00	0.32
Hardhead	0	2	15	17		0.00	0.15	0.82	2.54
Roach	0	0	0	0		0.00	0.00	0.00	0.08
Blackfish	0	0	0	0		0.00	0.00	0.00	0.02
Hitch	0	0	0	0		0.00	0.00	0.00	0.00
Tule perch	0	0	40	40		0.00	0.00	2.20	1.20
Sucker	0	17	41	58		0.00	1.26	2.25	0.72
Sculpin	0	0	0	0		0.00	0.00	0.00	0.00
Stickleback	0	0	0	0		0.00	0.00	0.00	0.00
Hatchery steelhead	0	1	0	1		0.00	0.07	0.00	0.00
Smallmouth bass	8	5	12	25		0.62	0.37	0.66	2.60
Largemouth bass	0	0	0	0		0.00	0.00	0.00	0.00
Bluegill	0	0	0	0		0.00	0.00	0.00	0.04
Green sunfish	0	0	0	0		0.00	0.00	0.00	0.00
Redear sunfish	0	0	0	0		0.00	0.00	0.00	0.00
Crappie	0	0	0	0		0.00	0.00	0.00	0.00
American shad	0	1	0	1		0.00	0.07	0.00	0.02
Carp	0	0	0	0		0.00	0.00	0.00	0.17
Bullhead	0	0	0	0		0.00	0.00	0.00	0.00
White catfish	0	0	0	0		0.00	0.00	0.00	0.00
Striped bass	1	0	0	1		0.08	0.00	0.00	0.00
TOTAL	**10**	**26**	**108**	**144**		**0.77**	**1.93**	**5.93**	**7.71**

Appendix F. Number of fish caught and catch-per-unit-effort, in Reach #3 shoreline sampling stations, Mirabel Study Area, August 2002.

	NUMBER CAUGHT					CATCH-PER-UNIT-EFFORT				
							Minutes sampled			
						9.18	7.68	11.05	11.25	39.16
Species	Station 2	Station 3	Station 5	Station 6	Totals	Station 2	Station 3	Station 5	Station 6	Totals
Wild steelhead	5	0	0	0	5	0.54	0.00	0.00	0.00	0.13
Chinook	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Pikeminnow	14	6	2	1	23	1.53	0.78	0.18	0.09	0.59
Hardhead	19	10	18	12	59	2.07	1.30	1.63	1.07	1.51
Roach	4	0	0	1	5	0.44	0.00	0.00	0.09	0.13
Blackfish	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Hitch	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Tule perch	10	4	3	3	20	1.09	0.52	0.27	0.27	0.51
Sucker	15	14	33	29	91	1.63	1.82	2.99	2.58	2.32
Sculpin	1	0	0	0	1	0.11	0.00	0.00	0.00	0.03
Stickleback	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Hatchery steelhead	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Smallmouth bass	16	8	18	23	65	1.74	1.04	1.63	2.04	1.66
Largemouth bass	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Bluegill	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Green sunfish	0	0	0	1	1	0.00	0.00	0.00	0.09	0.03
Redear sunfish	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Crappie	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
American shad	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Carp	0	0	1	2	3	0.00	0.00	0.09	0.18	0.08
Bullhead	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
White catfish	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Striped bass	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
TOTAL	**84**	**42**	**75**	**72**	**273**	**9.15**	**5.47**	**6.79**	**6.40**	**6.97**

Appendix F. Number of fish caught and catch-per-unit-effort in Reach 3, by station, Mirabel Study Area, Russian River, August 2002.

	NUMBER CAUGHT				CATCH-PER-UNIT-EFFORT		
Species			**Totals**				**Totals**
Wild steelhead	1	0	1		0.07	0.00	0.03
Chinook	0	0	0		0.00	0.00	0.00
Pikeminnow	0	2	2		0.00	0.11	0.06
Hardhead	0	1	1		0.00	0.06	0.03
Roach	0	0	0		0.00	0.00	0.00
Blackfish	0	0	0		0.00	0.00	0.00
Hitch	0	0	0		0.00	0.00	0.00
Tule perch	7	12	19		0.47	0.68	0.58
Sucker	13	20	33		0.87	1.14	1.02
Sculpin	0	0	0		0.00	0.00	0.00
Stickleback	0	0	0		0.00	0.00	0.00
Hatchery steelhead	0	0	0		0.00	0.00	0.00
Smallmouth bass	9	1	10		0.60	0.06	0.31
Largemouth bass	0	0	0		0.00	0.00	0.00
Bluegill	0	0	0		0.00	0.00	0.00
Green sunfish	0	0	0		0.00	0.00	0.00
Redear sunfish	0	0	0		0.00	0.00	0.00
Crappie	0	0	0		0.00	0.00	0.00
American shad	0	0	0		0.00	0.00	0.00
Carp	1	0	1		0.07	0.00	0.03
Bullhead	0	0	0		0.00	0.00	0.00
White catfish	0	1	1		0.00	0.06	0.03
Striped bass	0	0	0		0.00	0.00	0.00
TOTAL	**31**	**37**	**68**		**2.08**	**2.10**	**2.09**

Appendix G. Number of fish caught and catch-per-unit-effort, by station, Mirabel Study Area, Russian River, August 2002.

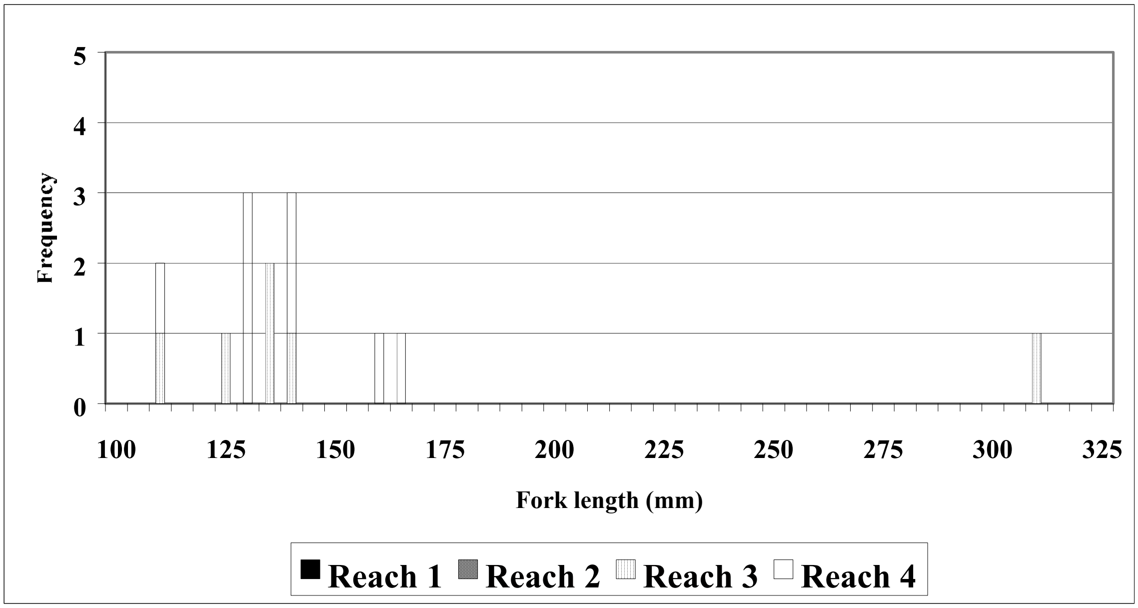
REACH 4 – Shoreline Habitats														
	NUMBER CAUGHT							CATCH-PER-UNIT-EFFORT						
Unit type/ Species	Left bank	Right bank	Left bank	Left bank	Left bank	Right bank	Total	Left bank	Right bank	Left bank	Left bank	Left bank	Right bank	Total
Wild steelhead	0	0	0	1	2	6	9	0.00	0.00	0.00	0.11	0.23	0.57	0.17
Chinook	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pikeminnow	7	10	3	1	3	18	42	1.02	1.08	0.31	0.11	0.35	1.71	0.78
Hardhead	22	19	47	26	12	81	207	3.21	2.05	4.90	2.97	1.41	7.70	3.87
Roach	3	1	0	3	4	28	39	0.44	0.11	0.00	0.34	0.47	2.66	0.73
Blackfish	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hitch	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tule perch	30	8	31	35	9	66	179	4.38	0.86	3.23	4.00	1.06	6.27	3.35
Sucker	13	10	28	40	23	43	157	1.90	1.08	2.92	4.57	2.70	4.09	2.93
Sculpin	1	0	0	0	1	0	2	0.15	0.00	0.00	0.00	0.12	0.00	0.04
Stickleback	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hatchery steelhead	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smallmouth bass	19	14	64	142	11	29	279	2.77	1.51	6.67	16.23	1.29	2.76	5.21
Largemouth bass	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bluegill	1	2	1	0	0	1	5	0.15	0.22	0.10	0.00	0.00	0.10	0.09
Green sunfish	0	1	0	6	1	5	13	0.00	0.11	0.00	0.69	0.12	0.48	0.24
Redear sunfish	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crappie	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American shad	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carp	1	1	1	0	0	0	3	0.15	0.11	0.10	0.00	0.00	0.00	0.06
Bullhead	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White catfish	0	0	0	2	0	0	2	0.00	0.00	0.00	0.23	0.00	0.00	0.04
Striped bass	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**97**	**66**	175	**256**	**66**	**277**	**937**	**14.16**	**7.12**	**18.23**	**29.26**	**7.75**	**26.33**	**17.51**

Appendix F. Number of fish caught and catch-per-unit-effort, by station, Mirabel Study Area, Russian River, August 2002.

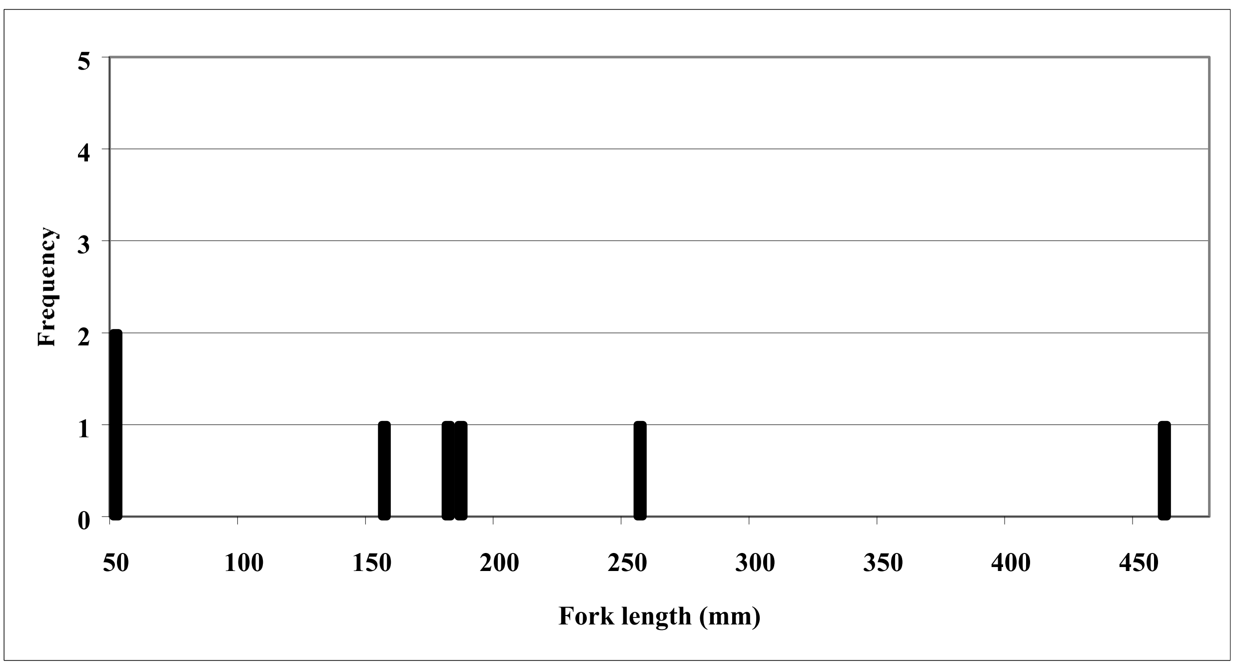
REACH 4 – Mid-channel Stations									
	NUMBER CAUGHT					CATCH-PER-UNIT-EFFORT			
Unit type	**Mid channel**	**Mid channel**	**Mid channel**			**Mid channel**	**Mid channel**	**Mid channel**	
Species	**Station 2**	**Station 5**	**Station 8**	**Totals**		**Station 2**	**Station 5**	**Station 8**	**Total**
Wild steelhead	0	0	0	0		0.00	0.00	0.00	0.00
Chinook	0	0	0	0		0.00	0.00	0.00	0.00
Pikeminnow	0	0	1	1		0.00	0.00	0.07	0.02
Hardhead	0	0	1	1		0.00	0.00	0.07	0.02
Roach	0	0	3	3		0.00	0.00	0.21	0.06
Blackfish	0	0	0	0		0.00	0.00	0.00	0.00
Hitch	0	0	0	0		0.00	0.00	0.00	0.00
Tule perch	19	5	6	30		1.02	0.37	0.42	0.64
Sucker	43	15	28	86		2.31	1.10	1.94	1.84
Sculpin	1	0	0	1		0.05	0.00	0.00	0.02
Stickleback	0	0	0	0		0.00	0.00	0.00	0.00
Hatchery steelhead	0	0	0	0		0.00	0.00	0.00	0.00
Smallmouth bass	2	1	2	5		0.11	0.07	0.14	0.11
Largemouth bass	0	0	0	0		0.00	0.00	0.00	0.00
Bluegill	0	0	0	0		0.00	0.00	0.00	0.00
Green sunfish	0	0	0	0		0.00	0.00	0.00	0.00
Redear sunfish	0	0	0	0		0.00	0.00	0.00	0.00
Crappie	0	1	0	1		0.00	0.07	0.00	0.02
American shad	0	0	0	0		0.00	0.00	0.00	0.00
Carp	0	0	2	2		0.00	0.00	0.14	0.04
Bullhead	0	0	0	0		0.00	0.00	0.00	0.00
White catfish	0	0	0	0		0.00	0.00	0.00	0.00
Striped bass	0	0	0	0		0.00	0.00	0.00	0.00
TOTAL	**65**	**22**	**43**	**130**		**3.49**	**1.62**	**2.98**	**2.79**

APPENDIX G

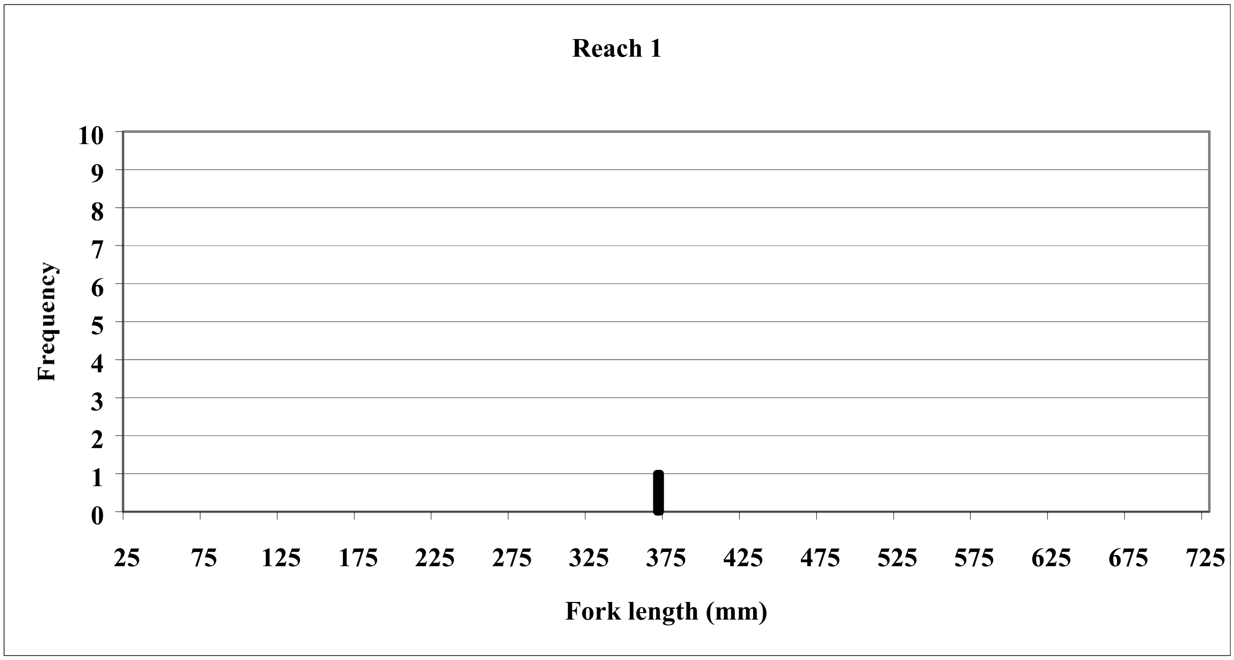
LENGTH-FREQUENCY HISTOGRAMS FOR EACH SECIES BY REACH COLLECTED DURING BOAT ELECTROFSIHING SAMPLING, AUGUST 2001, MIRABEL STUDY AREA



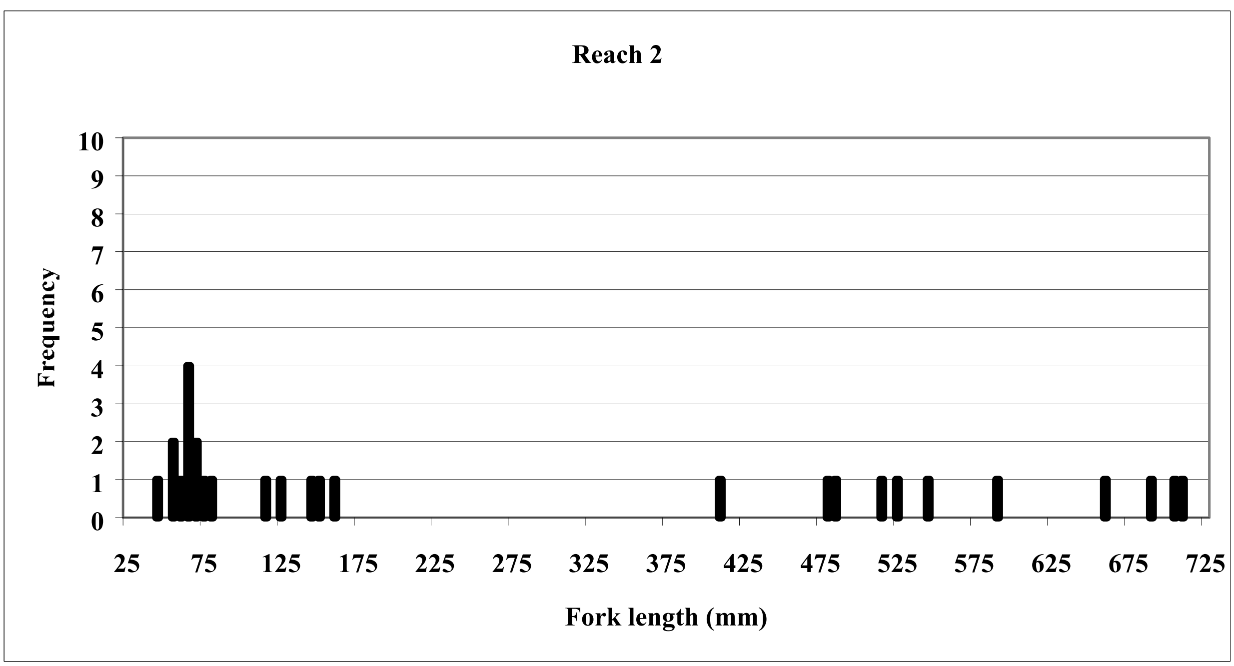
Appendix G. Wild steelhead length-frequency histogram, all reaches combined, August 2002.



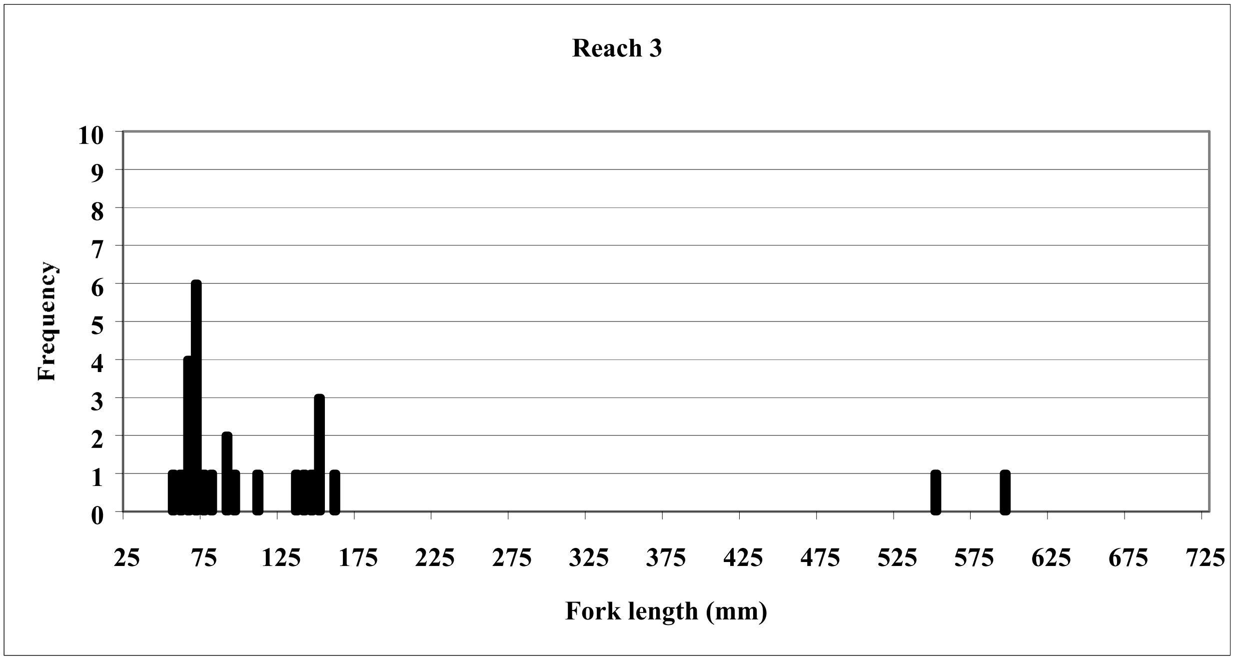
Appendix G. Largemouth bass length-frequency histogram (largemouth were only captured in Reach 1), August 2002.



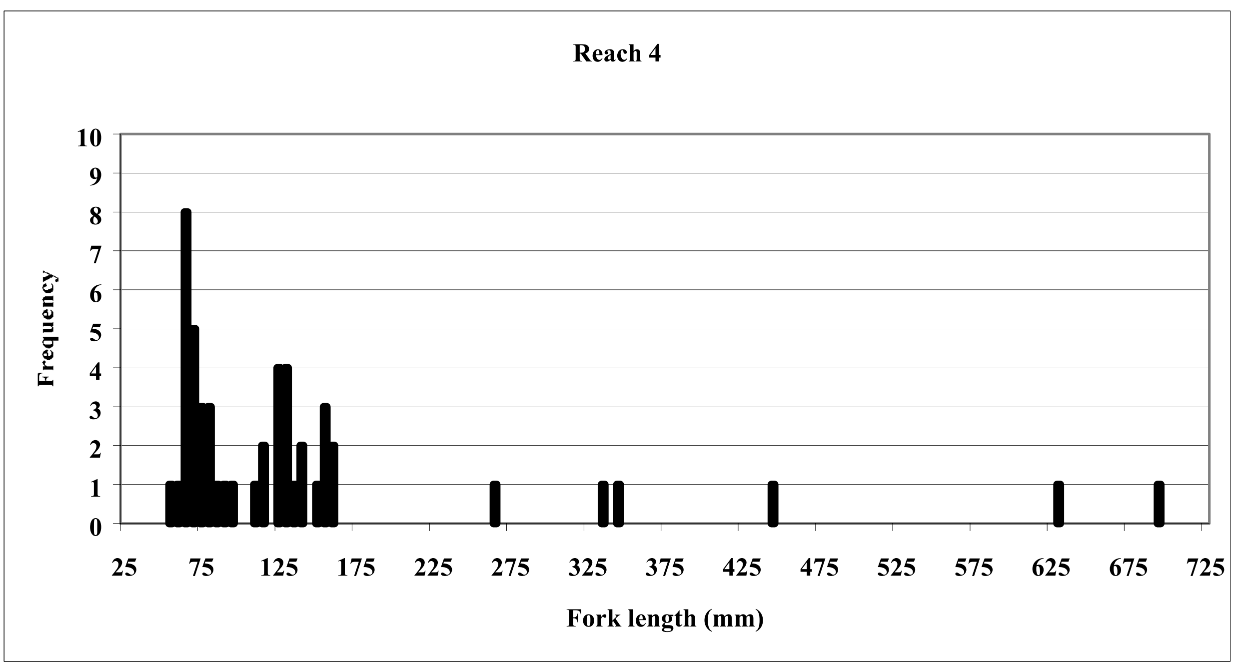
Appendix G. Pikeminnow length-frequency histogram, Reach 1, August 2002.



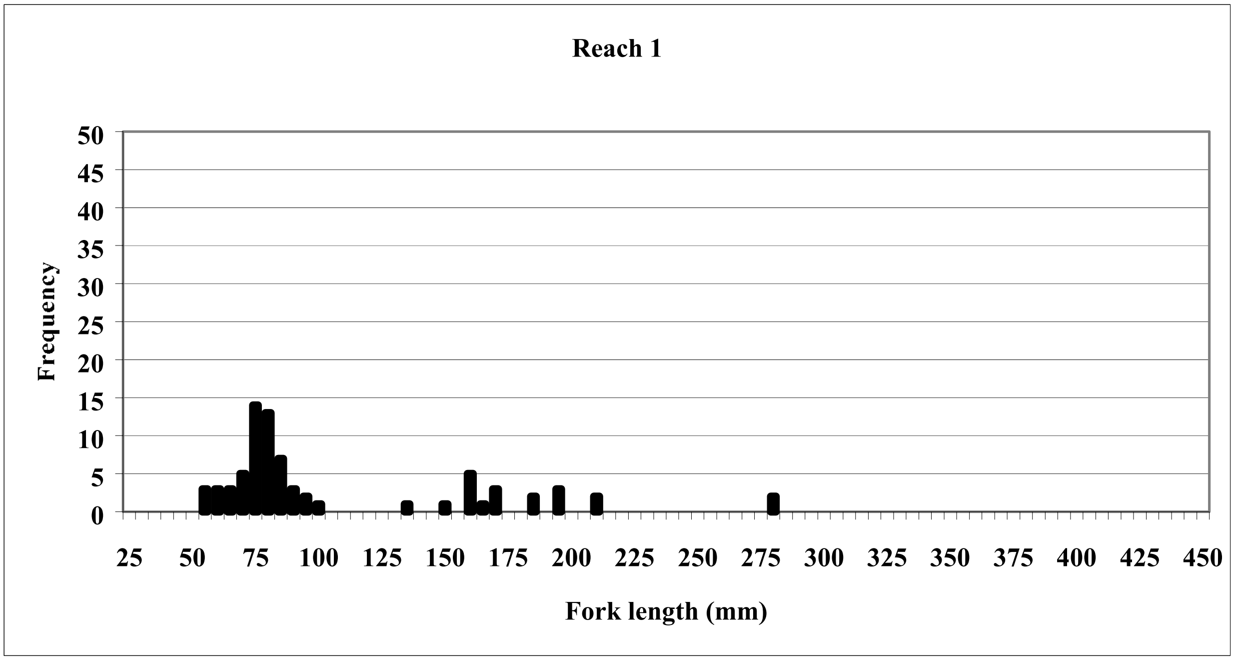
Appendix G. Pikeminnow length-frequency histogram, Reach 2, August 2002



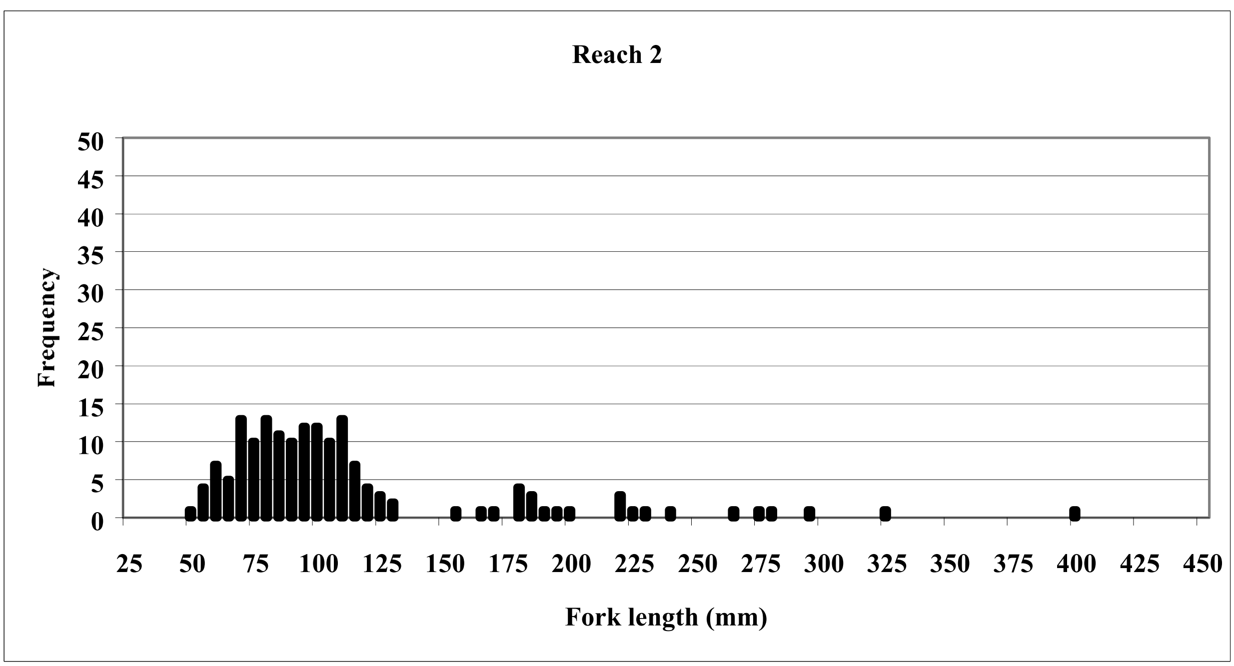
Appendix G. Pikeminnow length-frequency histogram, Reach 3, August 2002



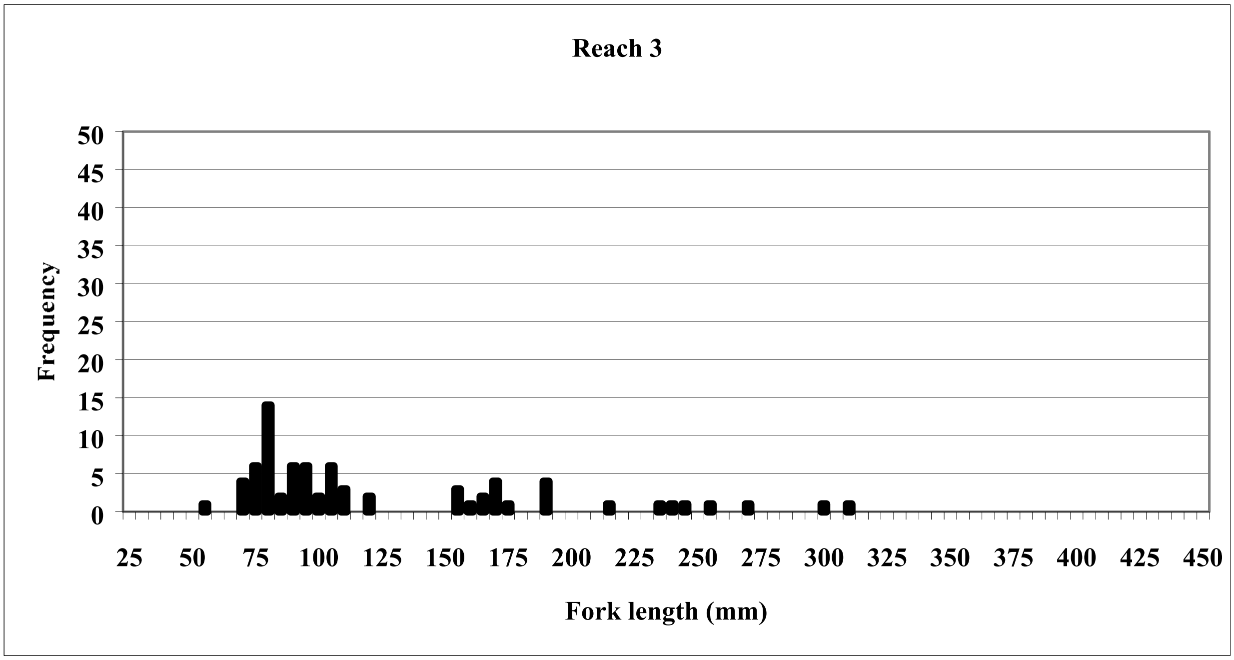
Appendix G. Pikeminnow length-frequency histogram, Reach 4, August 2002



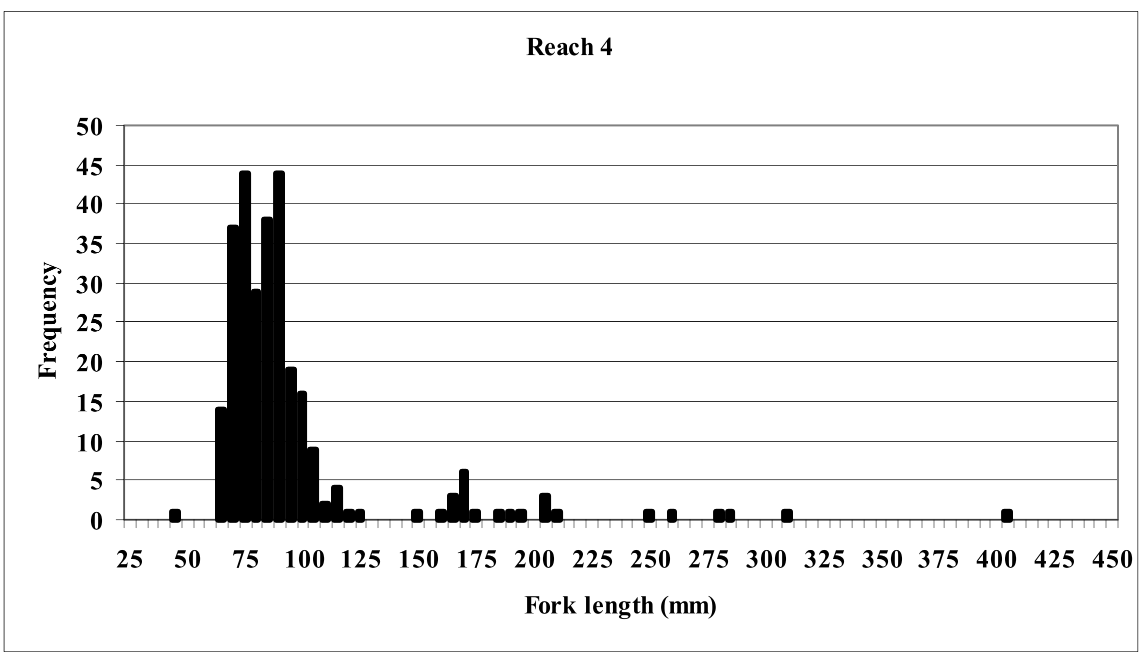
Appendix G. Smallmouth bass length-frequency histogram, Reach 1, August 2002



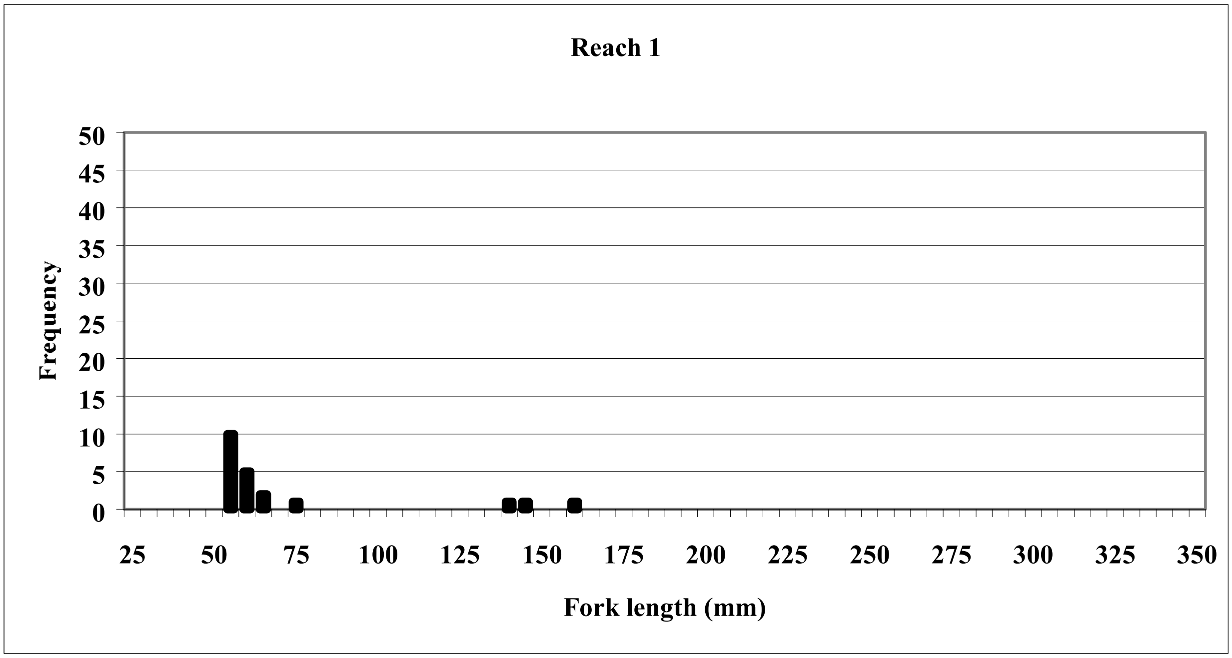
Appendix G. Smallmouth bass length-frequency histogram, Reach 2, August 2002



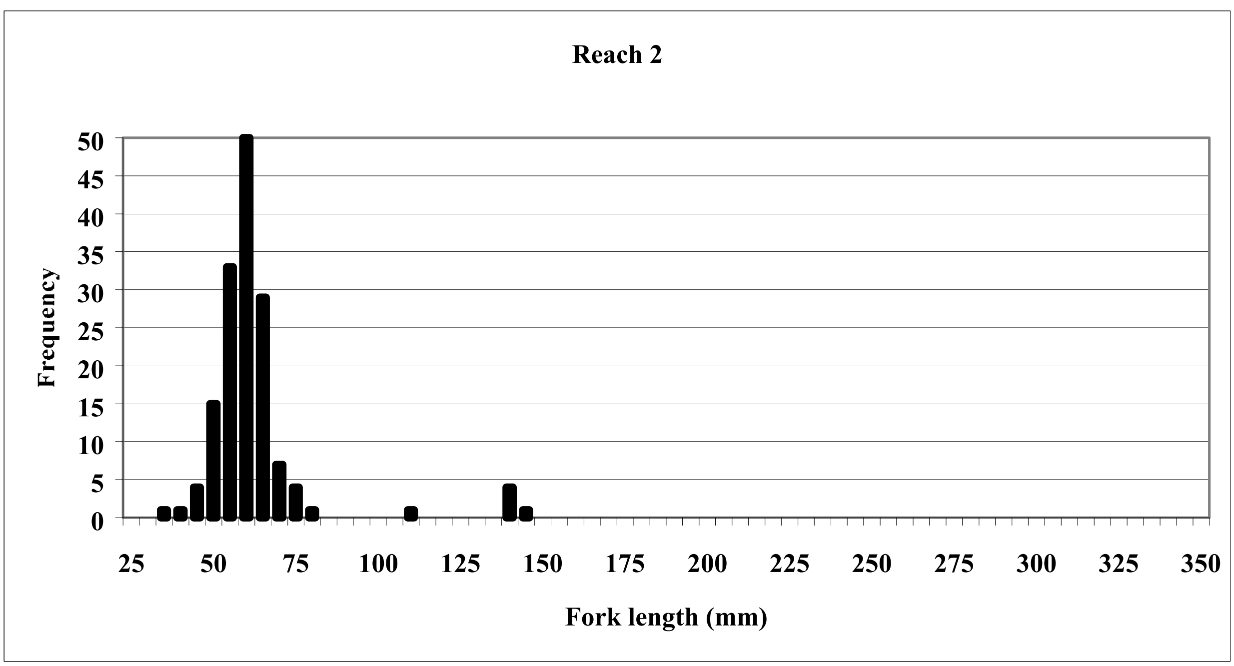
Appendix G. Smallmouth bass length-frequency histogram, Reach 3, August 2002



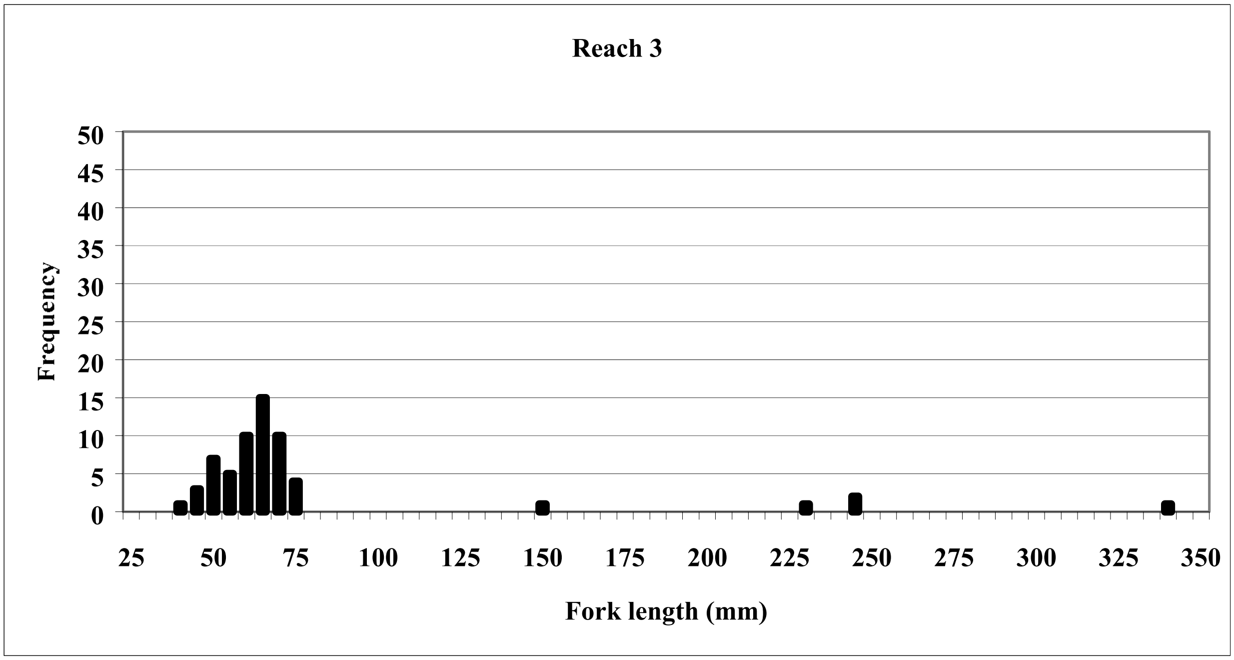
Appendix G. Smallmouth bass length-frequency histogram, Reach 4, August 2002



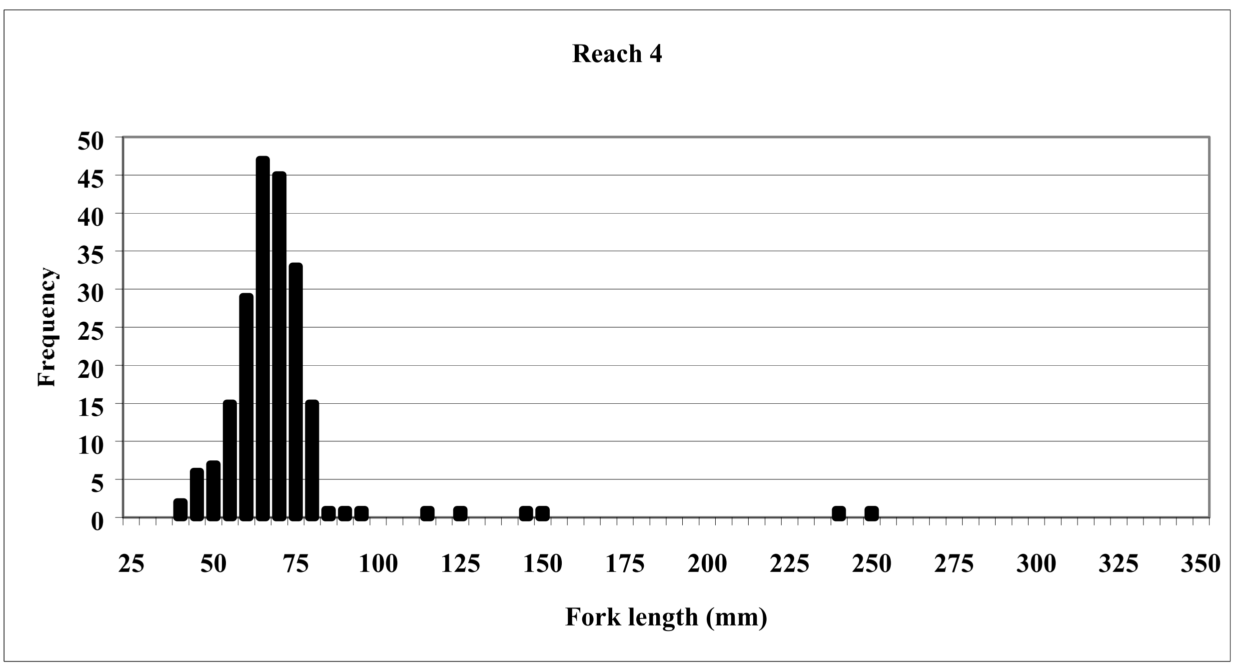
Appendix G. Hardhead length-frequency histogram, Reach 1, August 2002.



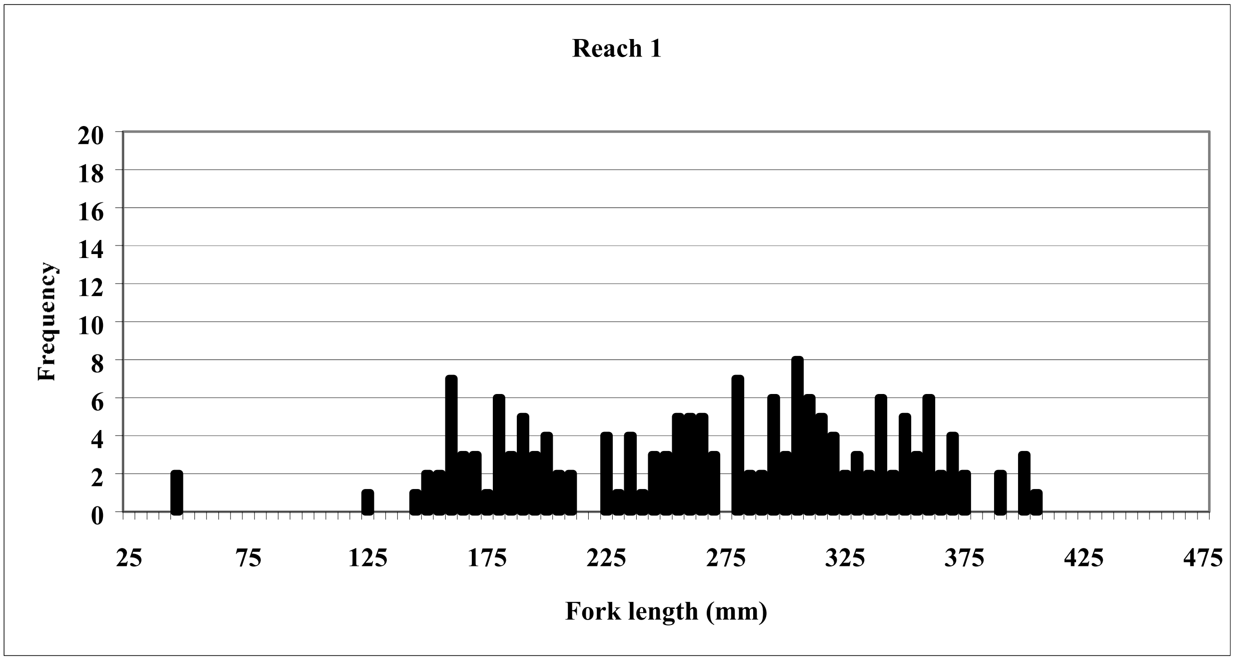
Appendix G. Hardhead length-frequency histogram, Reach 2, August 2002.



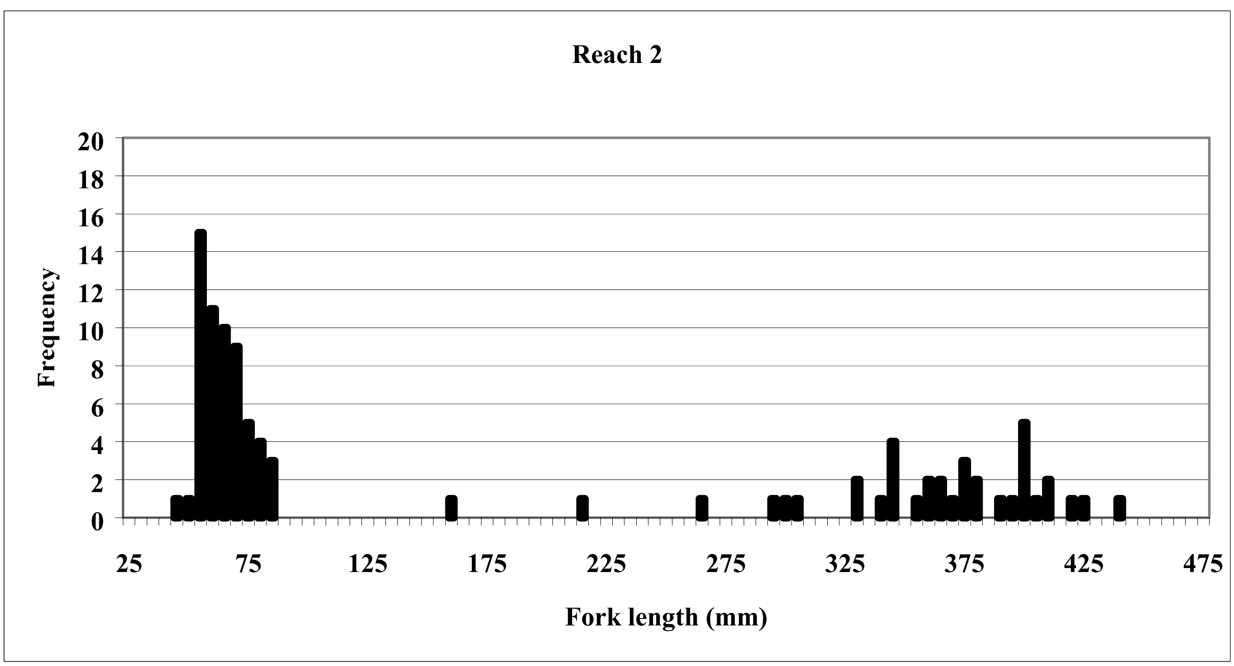
Appendix G. Hardhead length-frequency histogram, Reach 3, August 2002.



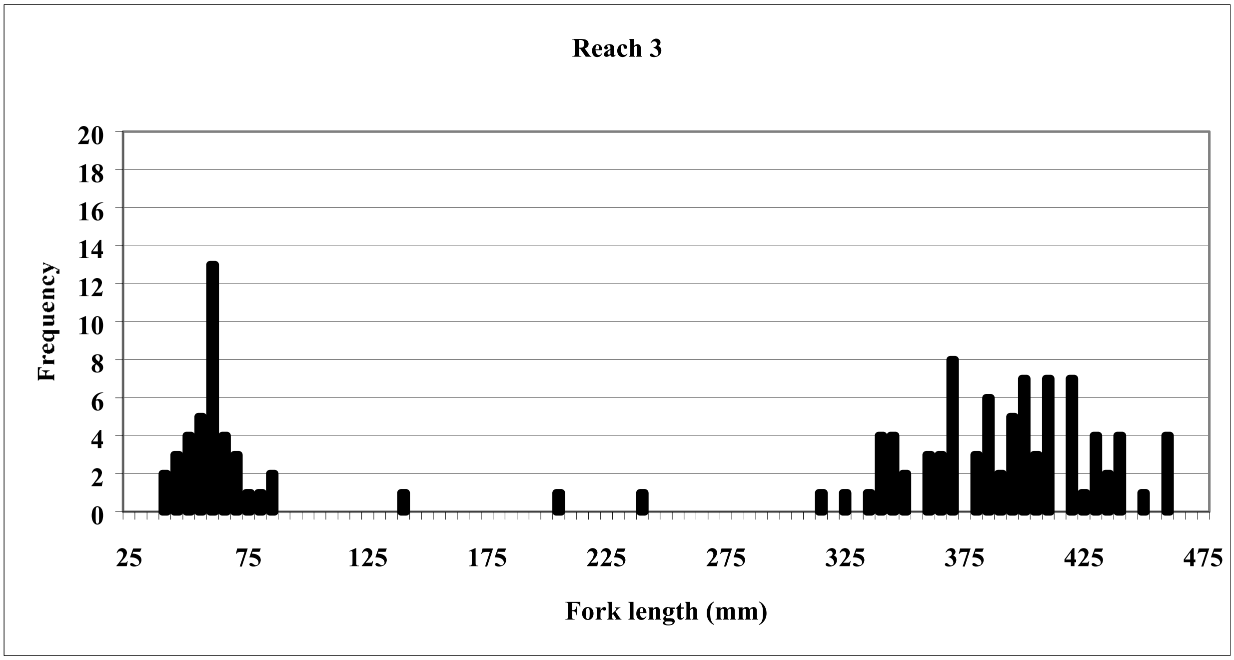
Appendix G. Hardhead length-frequency histogram, Reach 4, August 2002.



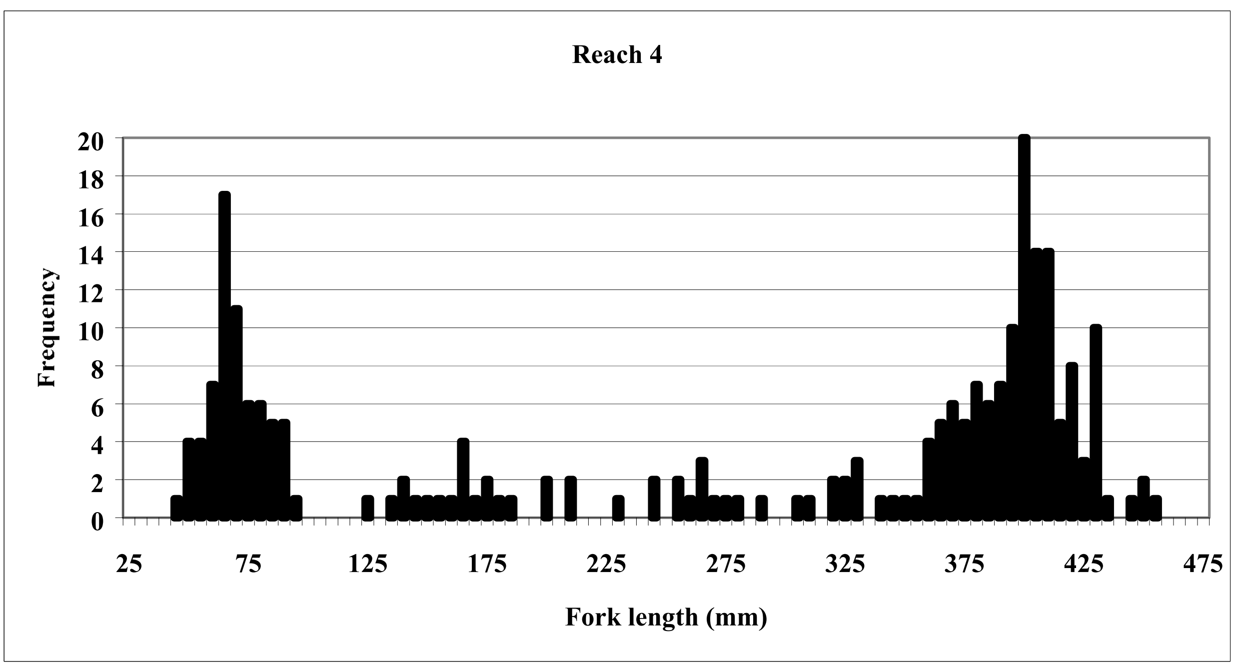
Appendix G. Sacramento sucker length-frequency histogram, Reach 1, August 2002.



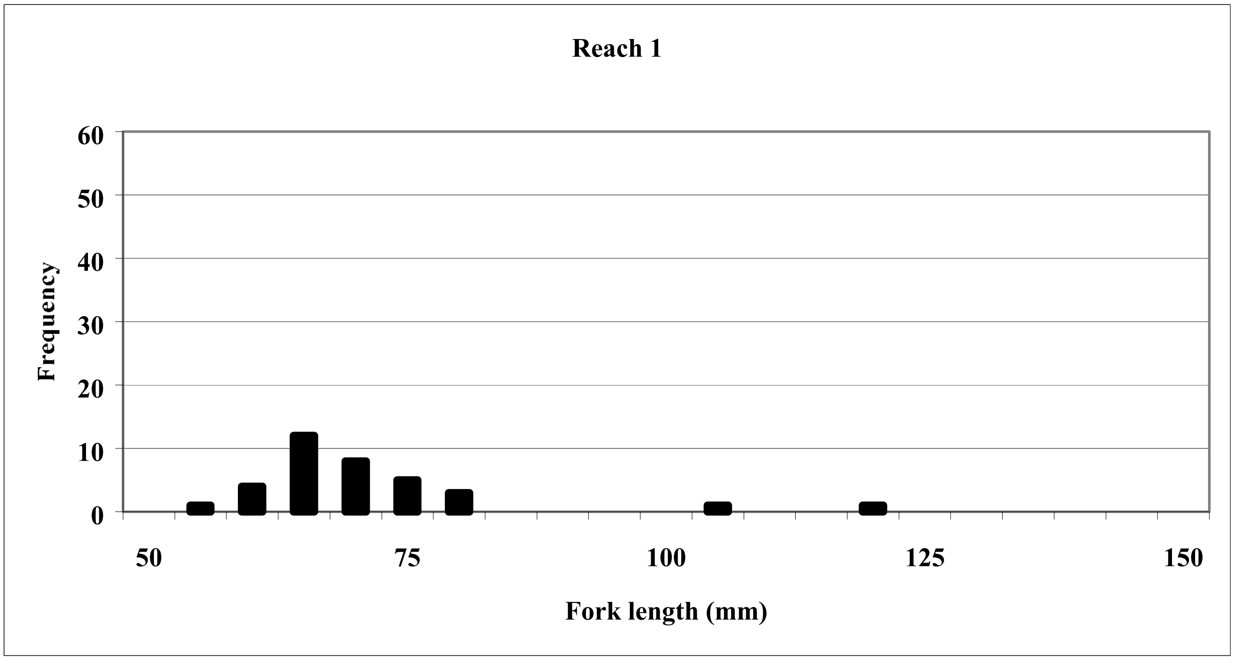
Appendix G. Sacramento sucker length-frequency histogram, Reach 2, August 2002.



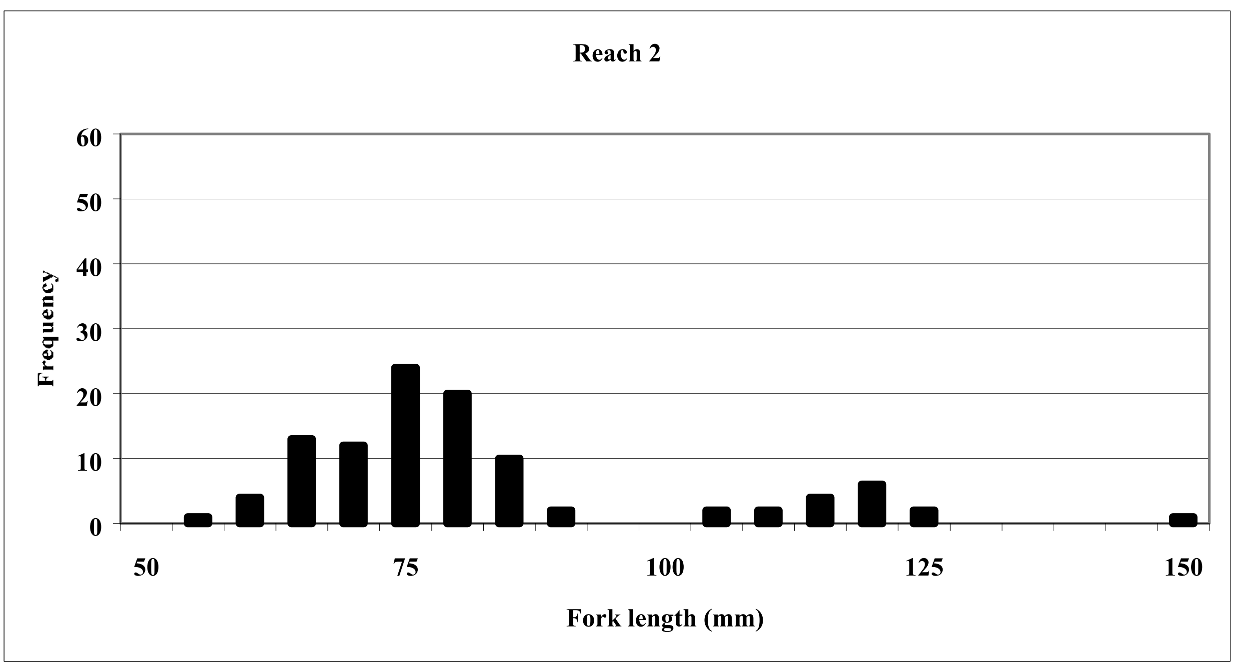
Appendix G. Sacramento sucker length-frequency histogram, Reach 3, August 2002.



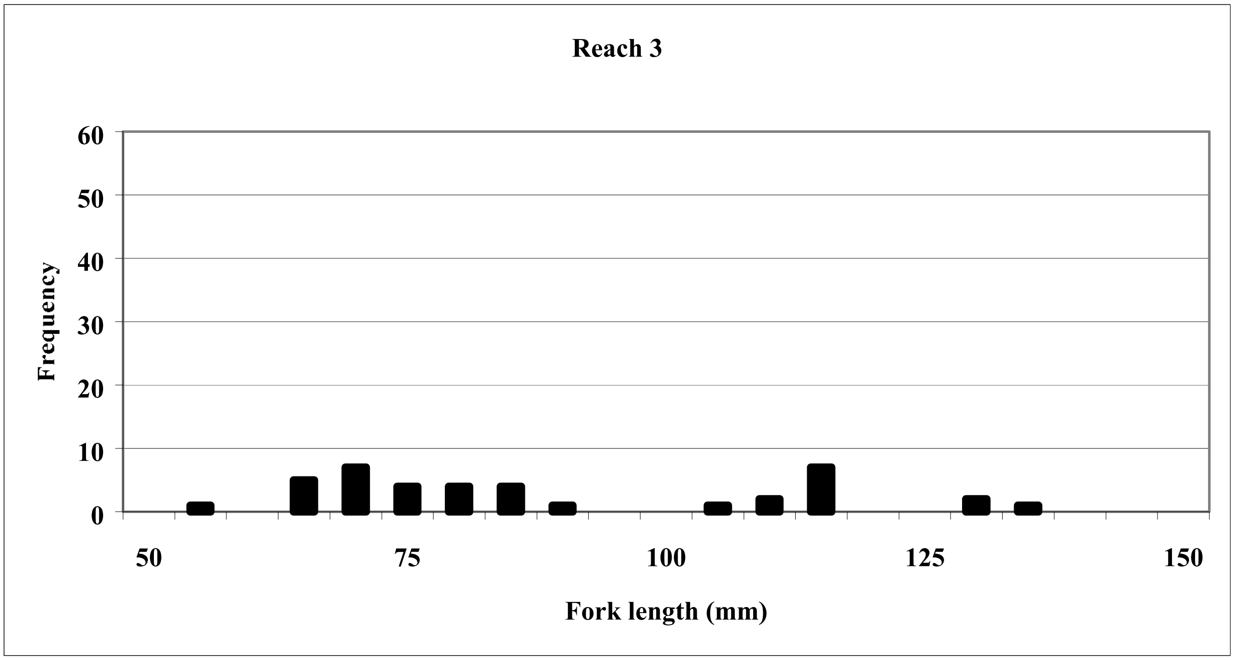
Appendix G. Sacramento sucker length-frequency histogram, Reach 4 August 2002.



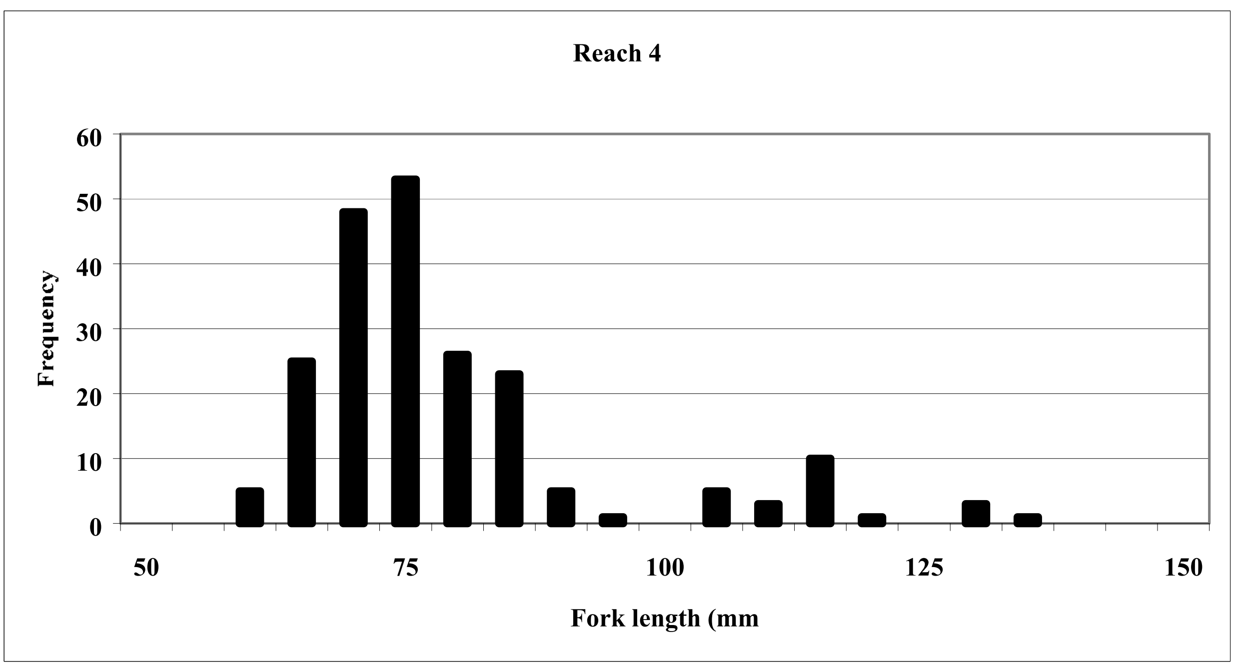
Appendix G. Tule perch length-frequency histogram, Reach 1, August 2002.



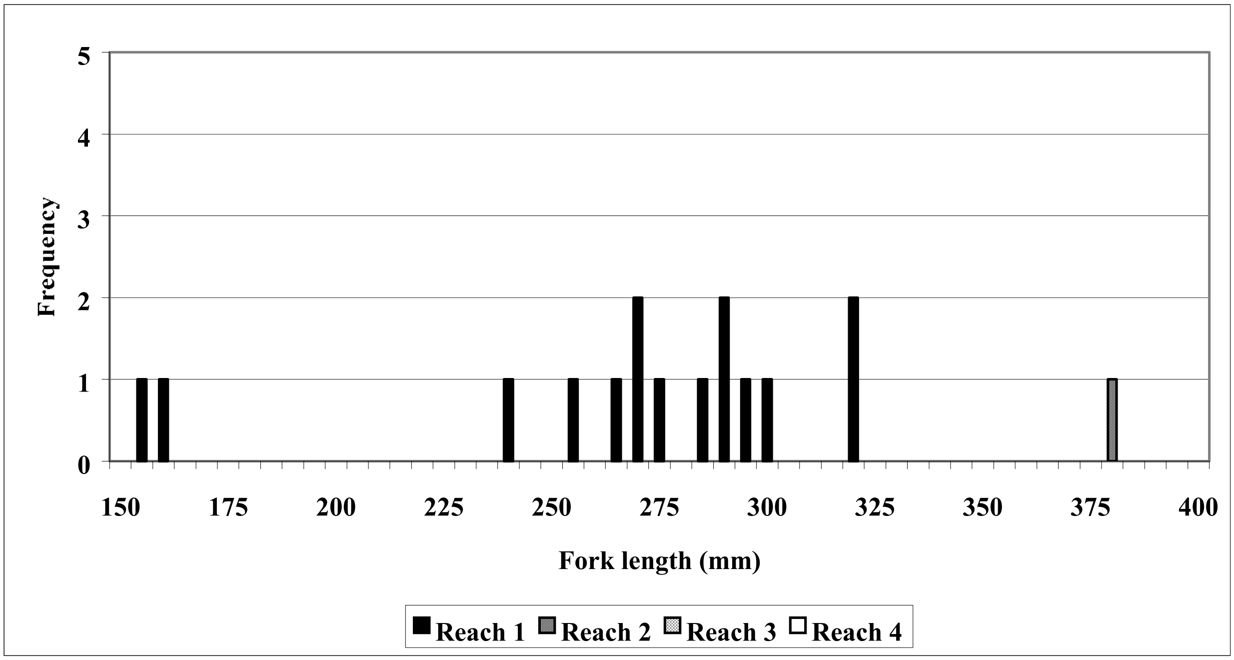
Appendix G. Tule perch length-frequency histogram, Reach 2, August 2002.



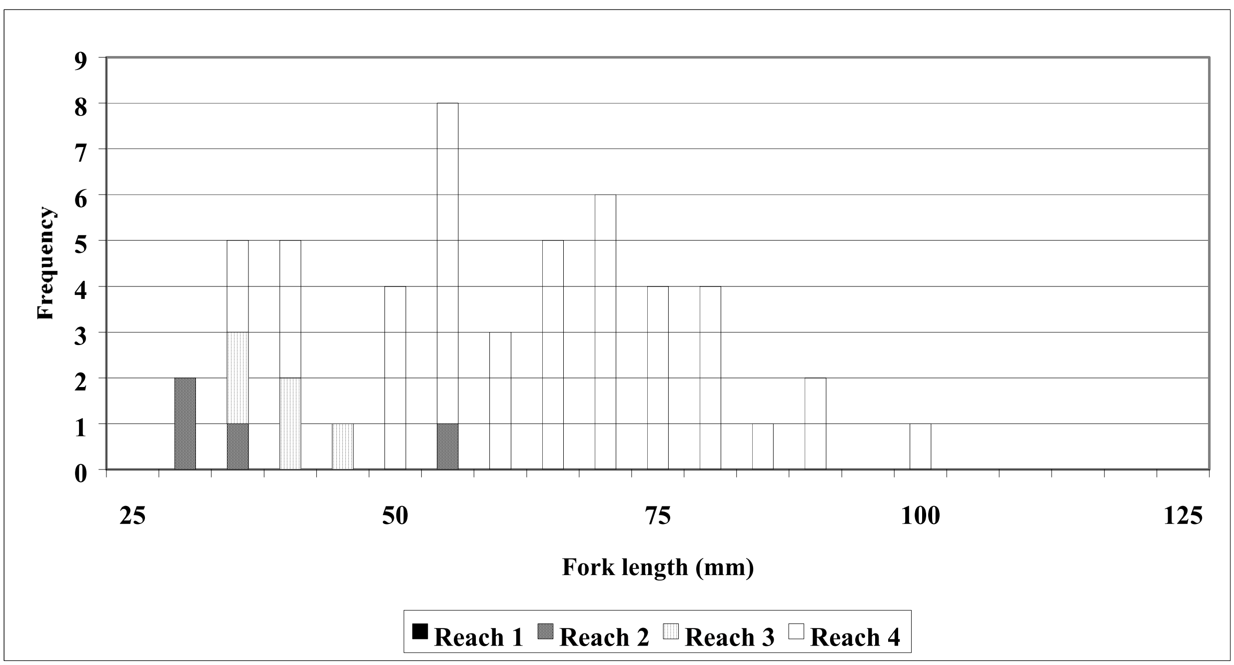
Appendix G. Tule perch length-frequency histogram, Reach 3, August 2002.



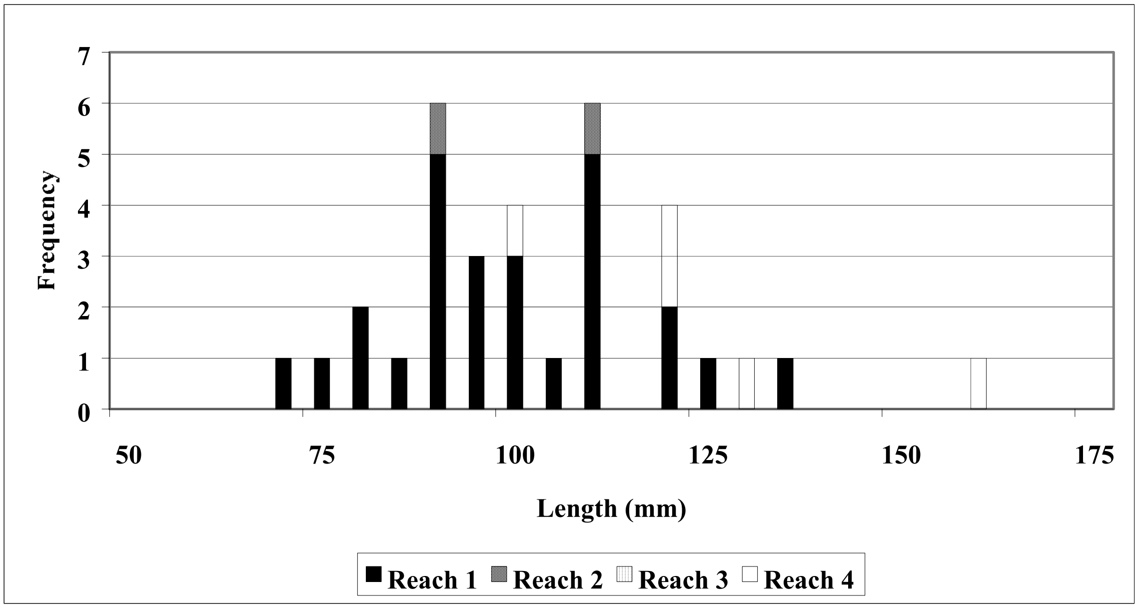
Appendix G. Tule perch length-frequency histogram, Reach 4, August 2002.



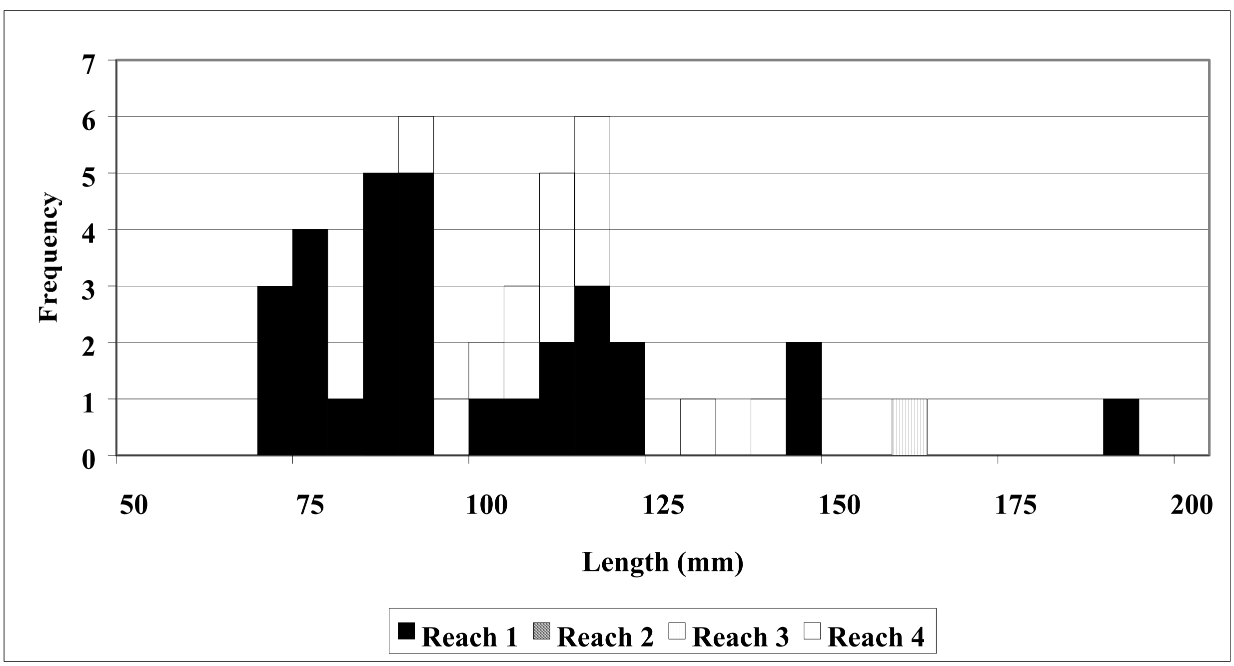
Appendix G. Blackfish length-frequency histogram, all reaches combined, August 2002.



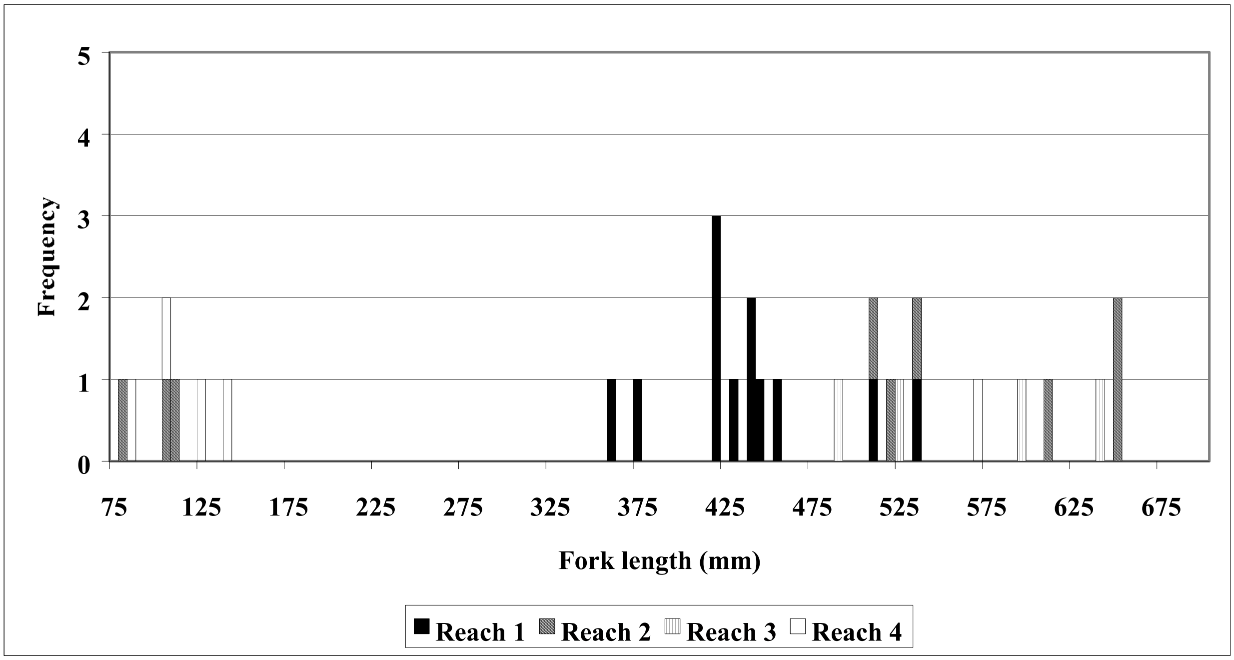
Appendix G. Roach length-frequency histogram, all reaches combined, August 2002.



Appendix G. Bluegill length-frequency histogram, all reaches combined, August 2002



Appendix G. Green sunfish length-frequency histogram, all reaches combined, August 2002.



Appendix G. Carp length-frequency histogram, all reaches combined, August 2002.

Appendix G. Lengths of fish species with less than five individuals captured during August 2002 surveys.

Species	Fork lengths (mm)
Bullhead	150
Chinook	115; 120
White crappie	130; 170; 180; 185
Redear sunfish	100; 115
Sculpin	60; 95; 100; 100
American shad	70; 85; 95; 390
Striped bass	915
White catfish	165; 170; 210; 320